THE UNIVERSITY OF ALBERTA

THE ROLE OF INCOME INEQUALITY ON FERTILITY IN LESS DEVELOPED COUNTRIES

by

Ⓒ Rodrigo Berrios

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF Master of Arts

Department of Economics

EDMONTON, ALBERTA
Fall 1986

Permission has been granted to the National Library of Canada to microfilm this thesis ~~and~~ to lend or sell copies of the film.

The author (copyright owner) has reserved other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without his/her written permission.

L'autorisation a été accordée à la Bibliothèque nationale du Canada de microfilmer cette thèse et de prêter ou de vendre des exemplaires du film.

L'auteur (titulaire du droit d'auteur) se réserve les autres droits de publication; ni la thèse ni de longs extraits de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation écrite.

ISBN 0-315-32443-0

THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR Rodrigo Berrios

TITLE OF THESIS **THE ROLE OF INCOME INEQUALITY ON FERTILITY IN LESS DEVELOPED COUNTRIES**

DEGREE FOR WHICH THESIS WAS PRESENTED Master of Arts

YEAR THIS DEGREE GRANTED Fall 1986

Permission is hereby granted to THE UNIVERSITY OF ALBERTA LIBRARY to reproduce single copies of this thesis and to lend or sell such copies for private, scholarly or scientific research purposes only.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

(SIGNED) ....

PERMANENT ADDRESS:

..Dpt. of Economics..........
..University of Alberta...
....

DATED October-14 1986

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled **THE ROLE OF INCOME INEQUALITY ON FERTILITY IN LESS DEVELOPED COUNTRIES** submitted by Rodrigo Berrios in partial fulfilment of the requirements for the degree of Master of Arts.

T. S. Veeman

Supervisor

Date October 9, 1986

DEDICATION

To my wife, Nancy;
my daughters:
Maria de los Angeles
and Camila Ignacia;
and
my parents

ABSTRACT

This study analyses the hypothesis of a negative relationship between income distribution and fertility in less developed countries. In particular, the direction of causality in the relationship and the existence of several indirect effects of income distribution on fertility are analyzed. The measurement and test of these effects permits an evaluation of income distribution as a tool aimed at reducing fertility.

The analysis uses two related simultaneous equation systems. These systems, based on the models of Repetto (1979), Flegg (1979), Gregory (1972) and Gupta (1982), capture the different aspects involved in the above relationship. The systems are estimated using a cross sectional data base consisting solely of less developed countries. Income distribution is measured by the share of the bottom forty percent of households in GNP. This measure is used, instead of the Gini index, because of its more direct association with absolute inequality.

The conclusions of the study can be summarized as follows. The existence of a negative direct effect of income distribution on aggregate fertility is confirmed. The reverse causality was not supported by evidence. Income distribution also has a negative overall indirect effect on fertility. The main influence occurs via the positive direct effect of income distribution on life expectancy and the powerful direct effect of life expectancy, in turn, on

fertility. A secondary indirect influence is associated with the negative relationship between the female participation rate and fertility. The study rejected the existence of a negative direct effect of income distribution on the female participation rate and of fertility on life expectancy, as well as a negative influence of fertility on income per head. The latter effects could have constituted further influences of income distribution on fertility.

The study suggests that policies designed either to improve education or to increase life expectancy may be preferred to a redistribution of income as a tool in reducing fertility. Education, for instance, was found to have approximately the same total effect on fertility as income distribution. However, an improvement in education also markedly increases income per head and savings, contrary to income redistribution. These two effects constitute an important consideration for less developed countries.

Finally, two further avenues of research to evaluate more completely the role of income distribution on fertility are suggested. First, education may be specified as dependent on income distribution. Second, the effects of income distribution on fertility may be treated as dependent on the level of development.

ACKNOWLEDGMENTS

This study could have not been completed without the assistance and encouragement of my supervisor, Dr. T. Veeman. In particular, I am grateful to Dr. Veeman for his enormous allocation of time, even sacrificing evening hours, in reviewing this work. As well, I must acknowledge the suggestions of Dr. K. Gupta for improving the final version of this study.

I am also grateful to several professors in the Departments of Economics. I must thank Dr. A. Buse for his invaluable help in econometrics and Dr. S. Sharir for his help in understanding some micro-economic aspects of the study.

I gratefully acknowledge the help of Drs. B. Scarfe and K. Krotki of the University of Alberta, as well as Mrs. Guillermo Maccio and Jorge Arevalo of Celade-Chile, for their contribution in obtaining financial assistance to complete my studies. I am specially gratefull to the University of Alberta and the Latin American Center of Demography: Celade-United Nations, for providing that assistance.

Correcting the English in this work has been a slow and unpleasant work. In this regard, I must thank, especially, my friends, Ioannos Tirkides and Bruno Amara.

Table of Contents

Chapter Page

1. INTRODUCTION 1

1.1 The Thesis 3

1.2 Specific Objectives of the Thesis 4

1.3 Organization of the Thesis 6

2. THREE APPROACHES TO THE INEQUALITY-FERTILITY RELATION 9

2.1 The Direct Approach 9

2.1.1 Reasons for the Non-Linear Relationship 11

2.1.2 A Note of Caution on the Hypothesis 16

2.2 The Structural Approach 18

2.3 The Indirect Effects of Inequality 23

2.4 The Implementation of the Three Approaches 25

3. THE MICROECONOMIC APPROACH TO FERTILITY AND INEQUALITY 28

3.1 Main Elements and Assumptions of the Micro Approach 28

3.2 A General Model of Demand 31

3.3 The Connection with Income Distribution 36

3.3.1 Factor Intensity Reversals and Substitutes for Child Rearing 37

3.3.2 The Earnings Interaction of Husband and Wife 39

3.3.3 Quality and Quantity of Children and Their Interaction 42

4. DETERMINANTS OF FERTILITY IN THE CONTEXT OF THE INEQUALITY-DEVELOPMENT RELATIONSHIP 46

4.1 Rationality and Inequality 46

4.2 Education and Inequality 55

4.3 Female Participation Rate and Inequality 59

4.4 Infant Mortality and Life Expectancy 66

4.5 Supply and Demand Sides of Fertility, and Inequality 68

4.5.1 Supply and Demand Interaction 70

4.5.2 The Relationship with Inequality 71

5. REVIEW OF THE EMPIRICAL LITERATURE 75

5.1 The Structural Empirical Work 76

5.2 The Mixed Empirical Work: Direct and Indirect Effects of Income Distribution 82

5.3 The Expanded Approach to the Economic-Fertility Relationship 85

5.3.1 Problems of Large Models 87

6. THE EMPIRICAL ANALYSIS 89

6.1 General Considerations 90

6.1.1 The Method and the Sample 90

6.1.2 The Measure of Income Inequality 92

6.1.3 Theoretical Issues in Simultaneous Equation Systems 95

6.1.3.1 Simultaneity 95

6.1.3.2 Choice of Functional Form 97

6.1.3.3 Other Constraints Imposed by Simultaneity 99

6.2 The Basic Model 99

6.2.1 The Rationale for the Model 99

6.2.2 The Model Specification 103

6.2.2.1 The Fertility Equation 105

6.2.2.2 The Life Expectancy Equation 109

6.2.2.3 The Income Distribution Equation 111

6.2.2.4 The Female Participation Rate Equation 114

6.2.3 The Results 115

6.2.3.1 OLS Results 116

6.2.3.2 TSLS Results 118

6.2.3.3 The Mechanism of the Inequality-Fertility Relationship 121

6.2.3.4 The Analysis of the Reduced Form 122

6.2.4 Limitations of the Basic Model 128

6.2.4.1 The Criterion for the Acceptance of Hypotheses 129

6.2.4.2 The Multicollinearity Problem 130

6.2.4.3 Exploratory Hypotheses 134

6.3 Changes in the Specification of the Basic Model 135

6.3.1 The Results of Modification One 138

6.4 The Expansion of the Demographic-Economic Analysis 145

6.4.1 The Specification of the Additional Equations 147

6.4.2 The Results of the Demographic-Economic Analysis 151

6.4.3 The Cost Associated with an Income Redistribution Policy 165

7. SUMMARY AND CONCLUSIONS 167

7.1 The Effects of Income Distribution on Fertility 169

7.2 Policy Evaluation 172

7.3 Suggestions for Further Research 176

REFERENCES 179

LIST OF TABLES

Table	Description	Page
4-1	The Insensitivity of Fertility with respect to Development	48
4-2	The Lag of Fertility with respect to Mortality	49
4-3	Relationship between Absolute Poverty and Fertility	54
4-4	Relationships among Female Participation Rate, Development, Agricultural Stage and Crude Birth Rate	65
5-1	Relationship between Changes in Income Distribution over Time and Fertility	78
5-2	The Atypical Character of the Studied Countries and Counter Examples	80
6-1	Ordinary Least Square Estimates of the Four Equation Simultaneous System--The Basic Model	117
6-2	Two Stage Least Square Estimates of the Four Equation Simultaneous System--The Basic Model	119
6-3	OLS Estimates of the Reduced Form Equations--The Basic Model	123
6-4	TSLS Estimates of the Reduced Form Equations--The Basic Model	124

6-5 Direct and Total Elasticities in the Basic Model 125

6-6 Linear Correlation Matrix of Principal Variables Used in the Basic Model 132

6-7 Analysis of Multicollinearity in the Basic Model 133

6-8 Comparison of TSLS Estimates between the Basic Model and Modification One 139

6-9 Selected Direct and Total Elasticities --Modification One 141

6-10 TSLS Estimates of Modification One--Using SR as a Proxy for Education 144

6-11 Two Stage Least Squares Estimates of the Expanded Model 152

6-12 Comparison of t-Ratios in the Demographic Equations between Modification One and the Expanded Model 154

6-13 TSLS Estimates of the Reduced Form Equations of the Expanded Model 159

6-14 Selected Direct and Total Elasticities of the Expanded Model 160

LIST OF FIGURES

Figure		Page
2-1	The Effect of Income Distribution on Aggregate Fertility	10
2-2	The Relationship between Fertility and Development	20
4-1	Interaction between the Demand and the Supply Side of Fertility	72

1. INTRODUCTION

Income distribution seems to have had an important role in the fertility reduction that occurred in countries such as Costa Rica, Sri Lanka, Taiwan and South Korea, the less developed countries (LDCs) most successful in reducing fertility in the last three decades. Furthermore, countries such as Mexico, Brazil and Philippines, where the process of economic growth has not been accompanied by improvements in income distribution, did not experience significant declines in their fertility rates (World Bank Report, 1984). These events have reinforced the hypothesis that improvements in income distribution should reduce the level of fertility in less developed countries.

Nevertheless, the role of income inequality on fertility remains as one of the least studied and understood of all the determinants of fertility in less developed countries (Birdsall, 1980). Further, such a role is still a subject of controversy and skepticism (Birdsall, 1977). This skepticism, in our judgement, lies in a number of factors. Firstly, the dogmatic interpretation and application of the micro-economic approach to fertility when analyzing the effect of income distribution; secondly, a misunderstanding with respect to the concept of income inequality used by a more structural approach to fertility ; finally, the non consideration of other interpretations of fertility, such as those associated with Easterlin (1976), Leibenstein (1973) and the sociological interpretation.

In the micro-approach the assumption of constant tastes and the doctrine of a positive income effect on fertility have led to misleading views of the effect of income inequality on fertility. Another misleading element would be the indiscriminate application of the micro analysis to the aggregate demand for children, or aggregate fertility level, without considering the conditions for such an aggregation.

With respect to what we have called the structural approach, the following sources of confusion can be noted. First, income inequality, differently than in a micro based approach, is considered a global determinant of fertility. That is, income distribution acts as a proxy for the fertility determinants other than income. Secondly, this approach views aggregate fertility as inversely related to the level of development; thus, the role of income distribution, together with income, is to define more accurately such a level of development in LDCs. Finally, this approach considers only "implicitly" the positive relation between the relative cost of children and development (Rich, 1973; Kocher, 1973). Therefore, what the structural approach aims at is a more aggregative explanation of fertility than the micro-approach.

Nevertheless, the hypothesis of a negative effect of income distribution on fertility is becoming more robust despite the controversy about it. The basis for such an effect rests mainly on a non-linear relation between income and fertilty at the household level, and many of the fertility interpretations are converging in showing such a non-linear relationship.

Indeed, the microeconomic approach to fertility has abandoned the idea that the income effect must necessarily be positive. On the contrary, it argues that the relation between income and fertility would be non-linear (Ben-Porath, 1973; Willis, 1973; Rosenzweig, 1981). The existence of such a non-linearity is also reinforced by other interpretations of fertility. For instance, the interpretation of fertility as an interaction of its demand and supply sides (Easterlin, 1976; Schultz, 1980), or the approach of Leibenstein (1973) suggesting that the commonly observed negative relationship between income and fertility can not be totally explained either by the rise in the relative cost of children or by a rise in children-quality. In addition, the theoretical basis of the structural approach rests on a threshold hypothesis, which implies again that the income-fertility relation is not linear.

1.1 The Thesis

This thesis postulates the existence of an important negative effect of income distribution on the fertility level in less developed countries. The main hypothesis is that an improvement in the income distribution of the society should reduce aggregate fertility. The analysis of such a hypothesis involves the examination of the following elements. First, the analysis of the mechanism via which income distribution affects fertility. That is, to discriminate between the direct, indirect and total effects of income distribution on fertility. Second, to compare the total effect, or multiplier, of income distribution on fertility with the respective multipliers of other policy variables, mainly education.

1.2 Specific Objectives of the Thesis

The analysis attemps to clarify theoretically, and in some cases to test empirically, the following propositions.

Income inequality, as a proxy of a more global concept of inequality, is a meaningful structural factor for explaining the fertility level in less developed countries. Further, patterns of economic growth biased to equality would be associated with low fertility while dualistic patterns--with high income concentration--should be associated with low levels of fertility.

Income distribution affects aggregate fertility negatively, even when most of the factors influenced by income inequality, which in turn influence fertility, are controlled. This also implies that income distribution has a direct effect on aggregate fertility, which is independent of the other traditional fertility determinants such as the female participation rate, life expectancy, education and income.

Income distribution also has indirect effects on the aggregate fertility level. It is convenient to distinguish two kinds of indirect effects. The first kind involves the consequences of an induced fertility decline--induced by the direct effect of an improvement in income distribution--on the female participation rate, income and finally life expectancy. Indeed, the decline in fertility is postulated to increase ultimately these variables, which in turn, will further reduce fertility. In addition, the induced fertility decline is also postulated to improve income distribution which also reinforces the fertility decline.

The second kind of indirect effects of income distribution on fertility are constituted by its hypothetical positive direct effect on life expectancy and negative direct effect on the female participation rate. The first effect will reinforce the decline in fertility while the second should partially offset such an induced fertility decline.

The consequences of a better income distribution and a fertility decline go beyond demographic effects. On the one hand, an improvement in income distribution is likely to deteriorate savings and thus the rate of growth of the economy. On the other hand, it will induce a fertility decline, which ultimately is likely to reduce the demographic pressures on savings and to raise per capita income. Therefore, a probable direct negative effect of income distribution on savings could be partially alleviated by a likely positive indirect negative effect of income distribution on savings.

1.3 Organization of the Thesis

The thesis is composed by eight chapters including the introduction and conclusions. In the second chapter, the three approaches that are used to explain and illustrate the effect of income inequality on fertility are reviewed: the direct-approach or direct effect of income inequality on fertility; the structural approach; and, finally, the indirect effects of income inequality on fertility. Chapter Three is a brief review of the micro-economic analysis of fertility. This review begins with the conventional model of fertility demand, but mainly it focuses on those micro-based models considered useful in explaining more formally the non-linear relation between income and fertility. In Chapter Four, the factors on which the three previously mentioned approaches are based are discussed from a developmental perspective. Two of the six sections of the chapter refer mainly to the structural approach and discuss the relation of inequality with rationality behavior, and the role of education, respectively. In the next two sections, the direct effects of income distribution on life expectancy and on the female participation rate are reviewed (the indirect approach). Finally, in the last section the interaction between the supply and demand sides of fertility is reviewed. Chapter Five is a brief review and criticism of the empirical work done on the subject, which becomes useful in providing a basis for a comparison with the empirical work done in this thesis. Chapter Six constitutes the empirical analysis of the thesis. In the first part of this chapter, general considerations about the method of analysis used (a cross sectional study of less developed countries), the characteristics of the sample and some issues involved in the use of simultaneous equation systems are explained. The second part of the chapter deals with the analysis of a four equation simultaneous system called the basic model. This system involves fertility, life expectancy, income distribution and female participation rate equations. It is used to examine primarily the demographic effects of income distribution. The analysis provides a comparison with the related models of Repetto (1979) and Flegg (1979).

In the third part of Chapter Six, the basic model is modified in the light of its limitations. In particular, income distribution is exogenized. Finally, the modified model is expanded through Gupta's (1982) model. Additional relationships between economic variables and fertility are incorporated and analyzed. This model permits a more realistic evaluation of a policy of income redistribution aimed at reducing fertility. That is, the model captures additional final effects of income distribution, education and other exogenous variables on the dependency rate, total labour participation rate, income per-head and savings. The consideration of these effects, in addition to the effects of income distribution on fertility, allows a more realistic policy evaluation.

In Chapter Seven, the conclusions and final assesments of the thesis are summarized.

2. THREE APPROACHES TO THE INEQUALITY-FERTILITY RELATION

The purpose of this chapter is to review, at a general level, the three approaches that we have used in the analysis of the effect of income distribution on fertility. Each of these approaches --the direct, the structural, and the indirect effects of income inequality--is treated in a separate section. Finally, in the last section, we explain briefly the way in which they have been incorporated in the analysis as a whole. We also discuss some of the limitations of the analysis.

2.1 The Direct Approach

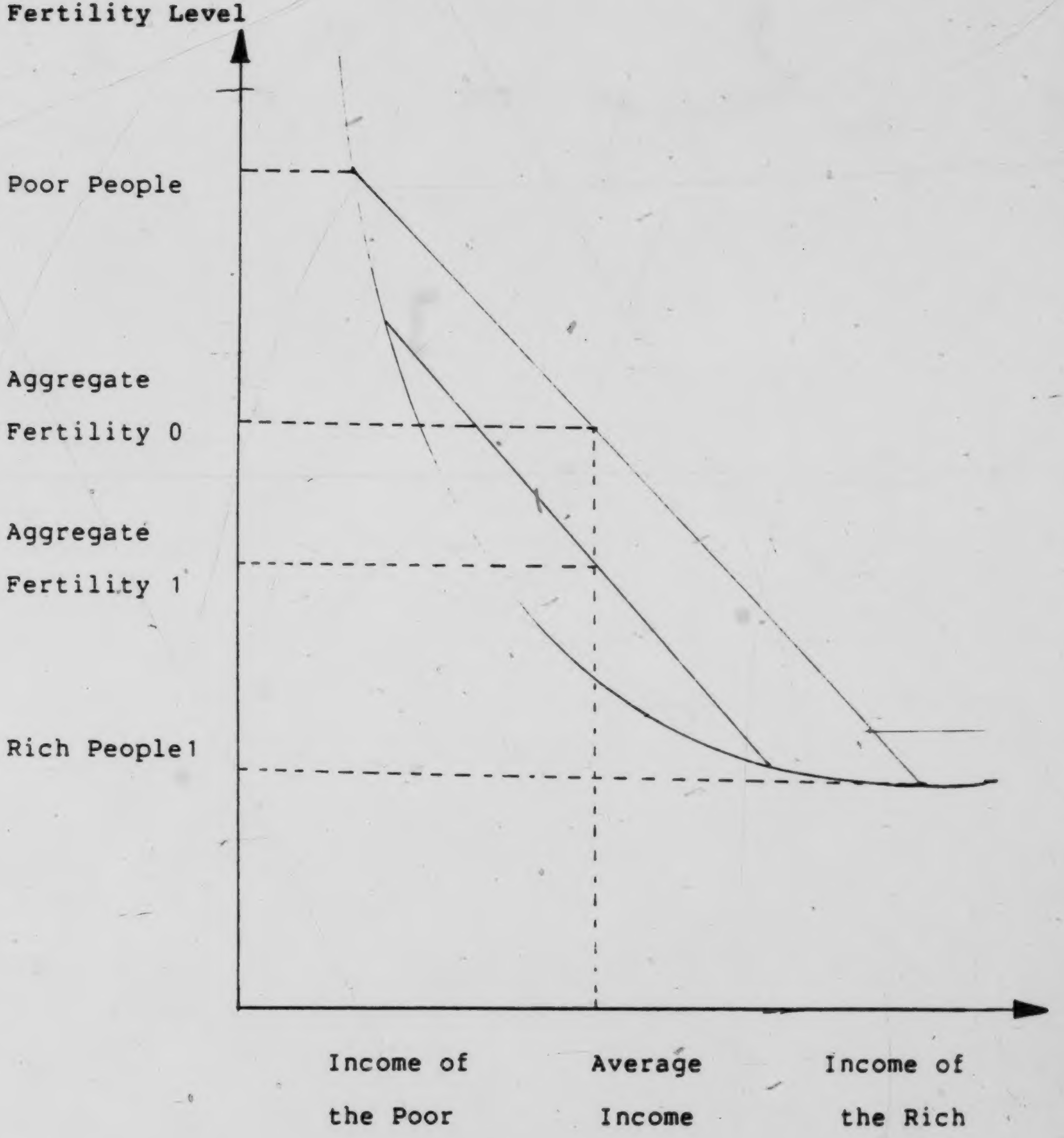
The justification for considering income distribution as a direct explanatory variable of aggregate fertility is given by the fact that the direct relationship between household income and fertility is non-linear. In particular, the hypothesis of a negative effect of income distribution on fertility rests on a postulated U-shaped relationship between household-income level and fertility. In this case, a change in income distribution in favour of the poor, when the average income of the society remains constant, should reduce aggregate fertility, as is illustrated in Figure 2.1 (Flegg, 1979; Repetto, 1974).

It is worth noting that the negative effect of income distribution on aggregate fertility is a particular case of the general hypothesis of a non-linear relationship between income and fertility. In fact, the effect of income

Figure 2.1

The Effect of Income Distribution

on Aggregate Fertility



Fertility Level
Poor People
Aggregate Fertility 0
Aggregate Fertility 1
Rich People1
Income of the Poor
Average Income
Income of the Rich

distribution on fertility may also be positive if this relationship takes an inverted U form, or may be negligible if the non-linearity between income and fertility is very weak (Rosenzweig, 1981). Therefore, the assumption of non-linearity between income and fertility sets up the case for considering income distribution as an argument in the fertility function. However, it does not determine the sign of its effect on fertility.

2.1.1 Reasons for the Non-Linear Relationship

The reasons underlying the non-linear relationship between income and fertility come from diverse interpretations of fertility, which are briefly reviewed as follows.

An integrated sociological and economic view of the relationship between fertility and development suggests that the explanatory variables of fertility interact with the level of development. That is, the sign of the income effect on fertility is likely to switch across different stages of development. This might be due to the fact that children, initially considered investment and security assets at low levels of development, become consumption goods at higher levels of development, when their costs outweigh their benefits. This change, in turn, must induce a shift in attitudes or tastes against children quantity and a bias towards the consumption of other goods. Therefore, after some level of development, children might become inferior goods for poor people, while they remain normal goods for rich people (Repetto, 1974; Flegg, 1979; Gregory and Campbell, 1976). A similar argument contends that income growth raises people's aspirations. A large number of children may become an obstacle towards satisfying these new aspirations. In these circumstances children may become inferior goods for the poor (Birdsall, 1980; Williams, 1976).

The microeconomic model of fertility which analyzes the interaction between husband and wife earnings on fertility, proposes that the income-effect on fertility should be negative at low income levels and positive at higher income levels (Willis, 1973). The interaction emerges because the wife's decision to work depends on the husband's wage level, and the effect of an exogenous increase in household income on fertility depends on the working status of the wife. This effect is more positive for working wives than for non-working wives. A supply side result of this model suggests that an equal amount of income given to poor and rich households will result in a greater substitution away from children quantity in poor households than in rich households. This would be the case when both poor and rich wives do not work in the market or work fixed hours. In this case, a rise in income raises the goods/time ratio used in the household production of commodities by the wife, and thus the marginal productivity and shadow value of her time. However, such a ratio increases proportionally more for poor wives, thus also the shadow price of their time increases proportionally more (Willis, 1973; Rosenzweig, 1981).

The non-linear relationship between income and fertility is also supported by Becker's approach. Becker (1973) analyzes the interaction between quantity and quality of children in the following way. The shadow prices of quantity of children and quality of children depend on quality and quantity of children respectively. Therefore, those prices are endogenous with respect to income. An exogenous increase in income then, by raising both quantity and quality demanded, increases both shadow prices. However, due to a bias of parents towards quality, the shadow price of quantity rises relatively more. This results in a substitution away from quantity towards quality. Most importantly, this substitution will be stronger for the poor than for the rich, because the former must incur a greater expenditure to achieve a similar proportional increase in quality than do the rich. Therefore, if poor and rich were given the same amount of income increase, the fertility of the poor would be reduced by more than that of the rich. The reason is that the quantity price faced by the poor would rise proportionally more than that faced by the rich (Rosenzweig, 1981).

A different argument is based on the assumption of different technologies used in the production of children by rich and poor households. Children of the rich are assumed to be market-goods intensive, while children of the poor are assumed to be mother's time intensive in their production. Therefore the relative price of children is positively related to increases in the wage of low-wage mothers and inversely related to increases in the wage rate of high-wage mothers (Gronau, 1977; Rosenzweig, 1981). The argument is also based on the relative price of mother's time substitutes in child rearing activities with respect to the mother's wage. These arguments applied to LDCs suggest that children from poor households would be produced by a free supply of mother's time substitutes: older children in the family (Rosenzweig, 1976; Birdsall, 1976). Children from rich households would be market-goods intensively produced, and children of middle income households would be mother's time intensive. Therefore, increases in the wage rate of the mother for different income level groups would affect fertility differently.

Further explanations can also be found in the demand/supply interpretation of fertility (Schultz, 1980; Easterlin, 1980). In general, the Easterlin approach to fertility states that fertility is supply determined at low levels of development and demand determined at higher levels of development. Furthermore, fertility can continue being supply determined well in advance of the development process if the cost of reducing fertility outweighs its benefits. Certainly, this is another source of non-linearities between household income and fertility for LDCs. Fertility is positively related to income at the very initial stages of development; this is so because a higher income improves the general health conditions of the population, thus the fecundity of the mother, and consequently fertility (Easterlin, 1981). A better income distribution can accelerate the switch from fertility being supply determined to being demand determined, thus, reducing aggregate fertility. An example of this could be a situation in which real fertility is above that of desired fertility, because immediate costs of controlling it are higher than the immediate benefits, in spite of a correct perception of children involving a net cost. In this latter situation an income redistribution, in favor of the poor, would certainly reduce aggregate fertility.

Flegg (1979) bases the argument of non-linearity between household income and fertility on the observation that cross-sectional data show a convex relationship between the crude birth rate and GDP. However, he does not mention if education, infant mortality, and the female participation have been controlled for in this relationship. If this were not the case, the observed convexity could be a spurious relation. Repetto (1979) uses the same argument but shows that the non-linear relationship between income and fertility arises even though the aboved mentioned variables are controlled.

2.1.2 A Note of Caution on the Hypothesis

It appears that there are valid arguments for postulating a direct effect of income distribution on fertility based on the non-linearities between income and fertility. Nevertheless, such non-linearities may be interpreted in different ways. One argument justifying the direct effect of income distribution on fertility is based on a non-linear relationship between exogenous income (non-labour earnings) and fertility. A second argument is based on the non-linear relationship between endogenous income (labour earnings) and fertility. Finally, another argument is based on the observation that the crude birth rate is non-linearly related with the GDP among different countries. A further clarification and assesment of these arguments is provided as follows.

The first type of argument presented posits a "pure" effect of income distribution on fertility. Equal exogenous increases in the income of rich and poor households will lead, it is suggested, to either different income effects, or a different response of the endogenous price of children for poor and rich households. To illustrate the meaning of these arguments, it is worth noting that they postulate that a transfer of income from rich to poor will reduce aggregate fertility. Furthermore, we may note that conventional micro theory does not allow substitution effects in the case of increases of income which correspond to transfers or non-earned income. Therefore these arguments posit a strong case for income redistribution.

The second type of argument presented states that increases in endogenous income--the combined wage earnings of the parents-will affect fertility depending on the household level of income. That is, whether the income or the substitution effect, associated with the wage increase, predominates depends on the level of household income. In general, it is assumed that substitution effects dominate for low-income households and income effects dominate for high-income households. Again, there is a strong case suggesting that income distribution affects aggregate fertility.

Flegg's argument based on cross-sectional observation is indeed very weak, as discussed previously. Nevertheless, the idea of non-linearity becomes sound if we consider that the subject of study is the aggregate demand for children, or total market demand. Then, income distribution can be considered an argument in the overall demand function for children--unless household tastes are homothetic, and thus the individual household Engel curves are linear, which is a highly unrealistic assumption (Green, 1976).

A different interpretation of the non-linear argument of Repetto (1979) and Flegg (1979) is that the rise in the relative cost of children cannot be totally isolated from income increases. Thus, to the extent that the cost of children rises at a decreasing rate with income, income distribution can be interpreted as a variable which proxies for and is directly related to the cost of children.

Finally, it must be emphasized that the non-linearity argument implies that income distribution affects fertility, although the direction of the effect must be indeterminate. The analyses of Becker (1973), Ben-Porath (1973), and Willis (1973) suggest that a better income distribution should decrease aggregate fertility. The analyses of Easterlin (1976), Rosenzweig (1981), and Gregory (1976) suggest that a better income distribution should increase aggregate fertility. Therefore, the direction of the effect of income distribution on fertility is likely to depend on the level of development.

2.2 The Structural Approach

The structural approach to the inequality-fertility relationship refers to that which takes into account all the effects of income distribution on fertility without discriminating between them.

This approach analyses the general, or gross role, of inequality on fertility. This implies, generally speaking, that when equality improves--meaning a higher absolute income for the poor, higher education, higher aspirations and better health conditions, the poor are shifted from a backward stage related with high fertility rates to a modern stage related with lower fertility rates. This is approximately the same explanation given by Simon (1979) and Heer (1963). They state that the final effect of "income" on the aggregate fertility of LDCs is negative.

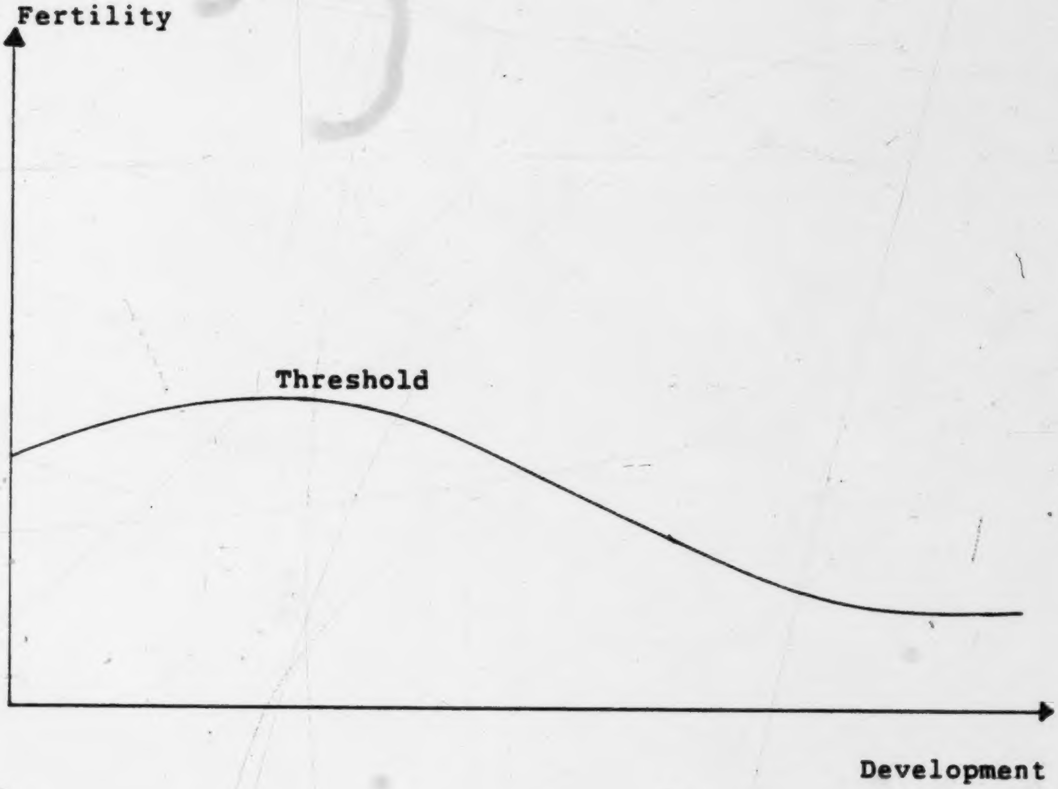
This approach is based on the generalization that those LDCs which were successful in reducing fertility, had previously achieved a higher spread of modernization within their populations. The suggestion is that the prerequisite for achieving that spread of modernization was the improvement in income inequality (Rich, 1956; Kocher, 1973).

Within the theoretical basis of the approach, there are two basic elements. First, fertility responds to a threshold stimulus. That is, people must arrive at some minimal level of education, health conditions, income and other welfare indicators, before reducing fertility. Second, income distribution partly summarizes these preconditions towards achieving a fertility reduction. That is, a high degree of income inequality is related to the absence of these preconditions and vice-versa. Thus, this variable, besides income, must be taken into account in defining the level of development of the population. It is this level which is inversely related to aggregate fertility (Krishnamurty, 1966; Bhattacharyya, 1975).

This interpretation is illustrated in Figure 2-2, which depicts the most likely relationship between development and fertility, or the "gross" relationship between income, as a proxy of development, and fertility. This relationship can be described as follows. At the initial stages of development, fertility might rise due either to a positive effect of an improved standard of living on fecundity

Figure 2-2

The Relationship between Fertility and Development



Source: Birdsall (1981).

(Easterlin, 1976), to an increase in the demand for children's work (Lindert, 1980), or finally because the net cost of children is likely to decline at these first stages of development (Rosenzweig, 1976). At higher levels of economic development, fertility will decline at a decreasing rate. The reasons being that fertility becomes completely demand determined, and development ultimately raises the relative cost of children, or enhances economic rationality, and it may turn attitudes against high fertility (Mueller, 1972; Repetto, 1979; Birdsall, 1977; Williams, 1976). Therefore, the statement of the structural approach is clear. A better income distribution shifts poor people from the left to the right of the threshold point; income distribution jointly with average income defines the level of development of the people of each country and thus its aggregate fertility level. Lastly, the potential for fertility reduction rests with poor people and not with rich people--that is, fertility converges to a minimal level as income increases (Birdsall, 1980; Leibenstein, 1973).

The problem with this approach is that it cannot elucidate the specific effect of income distribution on fertility. Actually, income distribution affects fertility via an effect on income, and through this variable on a long run modification of education, infant mortality, and the female participation rate, variables which will utimately modify fertility (Simon, 1979).

Indeed, this approach must be understood as a macro interpretation of fertility, which highlights the dependence of aggregate fertility on income inequality in LDCs. The bottom line of the structural view is its policy orientation. That is, in order to achieve a decline in fertility in LDCs, it would be more relevant to improve the income distribution rather than to attempt sometimes unfeasible, utopian, and normatively unfair propositions, such as raising the cost of children, controlling exogenously the supply side of fertility, or proposing a rise in education without development (Simon, 1974). Finally, the structural perspective does not deny the role of the traditional determinants of fertility--education, female participation rate, and infant mortality-- but it views all of them as dependent on income inequality; this is certainly true in a long-run analytical perspective.

Consequently, with the structural assumption that income distribution summarizes the fertility determinants other than income, the empirical attempts to prove the hypothesis of an inverse dependence of fertility on income distribution have , in general, used only income distribution and income as the explanatory variables of fertility (Rich, 1973; Kocher, 1973; Bhattacharyya, 1975).

Certainly, that analytical perspective has been criticized as an overestimation and misspecification of the role of inequality on fertility. In fact, it is argued that it is not income distribution which affects fertility, but higher education, lesser infant mortality, and other fertility determinants. This criticism states that there is not a proper role for income distribution on fertility other than that of the indirect and long run effect, or if this role exists, it would be incorrectly measured, and specifically overestimated (Birdsall, 1980; Flegg, 1979).

2.3 The Indirect Effects of Inequality

As was stated in the previous section, a great part of the effect of income distribution on fertility is the indirect long-run effect, which occurs via an increase in the absolute income of the poor, which in turn, modifies the determinants of fertility.

Nevertheless, income distribution is likely to have also a direct effect on infant mortality or life expectancy, and a likely effect on the female participation rate. These direct effects, as in the case of fertility, are based on a hypothetical non-linear relationship between life-expectancy and income (Flegg, 1979), and between the female participation rate and income.

Infant mortality and life expectancy are both phenomena related with income in a non-linear form. This is a reflection of the fact that there are diminishing returns in life expectancy with respect to income. What is behind this technicality is the fact that infectious diseases are much easier to control than endogenous or systemic diseases. In other words, life expectancy and infant mortality are income distribution dependent, as well as being a function of average income , urbanization, education, and other income dependent variables. The causes of death in LDCs, and specially infant death, are associated with a high incidence of diseases such as diarrhoea and influenza, which are mainly determined by socio-economic conditions (Preston, 1980; Rodgers, 1972). Therefore, improvements in income distribution , given a constant average income, should reduce the aggregate level of infant mortality or raise life expectancy, by the same argument of non-linearity used to explain the reduction in aggregate fertility. Therefore, given the positive relation between infant mortality and fertility, it should be expected that an initial improvement in income distribution acting through this improvement in health conditions should ultimately reduce fertility. (Schultz, 1980; Williams, 1976).

The female participation rate in the market is also likely to be income distribution dependent, as well as being function of average income and other variables.

A micro explanation for this is suggested by the fact that poor women in LDCs must allocate a higher number of hours to the market than richer women, in order to complement the household income and ensure the survival of the family. Therefore, it is quite likely that leisure will be a luxury good for poor women and a basic good for richer women, and thus the labour-supply curves of poor women and rich women be backward bending and positively sloped respectively. Thus, increases in high-wage rates are likely to increase the female participation rate of females from high-income households and increases in low-wage rates are likely to reduce the female participation rate of females from low-income households.

Certainly, this basic non-linearity between income and the female participation rate is likely to change in its direction, and again to be dependent on the level of development.

From a macro point of view, the aggregate information suggests that at very low levels of income per-head, the female participation rate tends to be high; to decrease when income rises; and, after certain levels of income, to increase again (United Nations, 1979).

The existence of a negative relationship between income distribution and the female participation rate would mean an offsetting effect to an initial reduction in fertility caused by an improvement in the income distribution.

2.4 The Implementation of the Three Approaches

The explanation of these three approaches was required to delimitate their application to both a theoretical and an empirical analysis of the income-distribution effect on fertility. In fact, usually these approaches are implicitly mixed in the analysis of the role of income distribution, which causes confusion on the subject (Repetto, 1979).

Each of the approaches entails theoretically a specific point of view with respect to the whole analysis.

The direct approach allows us to incorporate income distribution as an explanatory variable of fertility, besides income, infant mortality, education, the female participation rate and cultural factors. Theoretically, the approach allows the measure of the elasticities of fertility with respect to all of these variables, and thus a policy comparison among them.

The indirect approach allows us to analyze the effect of income distribution on two determinants of fertility: life expectancy and the female participation rate. Given that these two variables have mutual causation with fertility, it is possible to build a system to measure the effect of income distribution on fertility, when all their mutual influences are taken into account.

Finally, it seems that the structural approach has no role in an empirical analysis of fertility which incorporates as explanatory variables all the fertility determinants that are income-related: education, infant mortality, and the female participation rate. Nevertheless, cross-country analyses represent a long run situation, where the control exerted on different variables is not perfect. Given this, it is likely that the income distribution variable is capturing all those long-run effects of education and infant mortality, or simply defining more accurately the cost of children in each society (Simon, 1974; Flegg, 1979). In this case, the structural role of income distribution on fertility can not be distinguished from its direct effect, and thus still has a role in fertility determination.

3. THE MICROECONOMIC APPROACH TO FERTILITY AND INEQUALITY

The main purpose of this chapter is to provide a more formal explanation of the direct effect of income distribution on fertility in light of the microeconomic models of fertility. In addition , the theoretical framework of the microeconomic approach is reviewed here as its concepts and general propositions are useful for an applied analysis of the determinants of fertility.

3.1 Main Elements and Assumptions of the Micro Approach

The microeconomic approach to fertility has evolved from a basic demand approach (Becker, 1960) to more sophisticated models of general equilibrium, such as those of Willis (1973), Becker and Lewis (1973), Gronau (1973), and Michael (1976). In what follows, we will briefly mention only those aspects and assumptions that are most important and relevant to the analysis at hand rather than giving a detailed account of the vast literature on the subject.

In the basic demand approach, children are viewed as durable consumer goods--assumed to be normal goods--which provide utility to their parents either via monetary or real income, and/or a subjective psychological satisfaction. This utility is compared with the utility derived from other goods which are non-related with children. Parents are assumed to be rational and their tastes with respect to children are assumed to be relatively fixed (Becker,1965).

The demand for children can be obtained through the maximization of the parents' utility subject to the family income constraint. Analytically, however, there exist certain differences between the demand for children and that for any other good. Firstly, the direct price of children is not observable; generally it can be approximated by its indirect price, which is proxied by the value of time spent on child-rearing, when this constitutes a foregone income for parents. Most importantly, the relative price of children is no longer exogenous, as in the usual demand analysis. Indeed, it is endogenous to the actual or potential wage of the parents, especially of the mother. Finally, in their demand for children parents have a bias or preference towards quality rather than quantity of children (Becker, 1960; Shultz, 1981).

The new home-economics approach, associated with Willis (1973), Ben-Porath (1973), Gronau (1973), and Michael (1976), among others, sees the household (a couple of parents) as a general equilibrium system or as a dual unit of production and consumption. That is, the household produces the commodities that are finally consumed. In order to simplify the analysis, the commodities produced at home can be aggregated into child services (number of children of a given quality) and standard of living (composite commodity of all commodities not related with children).

The production of these commodities uses as inputs, the time of parents and market goods. The production functions are typically assumed to be homogeneous of degree one, so as to facilitate the economic analysis. Children are assumed to be mother's time intensive in their production relative to the composite commodity (standard of living). In general, the father's allocation of time to home production is considered negligible.

The household faces two constraints when maximizing utility: a time constraint, the total disposable parental time to be allocated either in market or house-production activities; and a monetary income constraint, which is the sum of the market wage and non-wage income of parents. Both constraints can be aggregated together into the full income constraint. In this process, parental disposable time is valued in terms of appropiate shadow prices (using the respective market wages if parents are working and the potential market wage in the case of the non-working spouse).

The problem of constrained maximization obtained thereof is viewed as a dual process of minimizing full income subject to the production possibilities or of maximizing utility subject to the full income constraint. This dual process allows us to analyze the fertility behavior of the family from both sides: the demand and the supply or production side (Willis, 1973).

3.2 A General Model of Demand

The following is a widely used general model of fertility demand that incorporates the basic assumptions of the new home economics approach. It is used here to illustrate the basic propositions of this approach.

The symbols used are:

c = children services

n = number of children

s = standard of living

q = constant quality per child

T_{ij} = total time spent by individual i on the production of commodity j

t_{ij} = time input of individual i into one unit of the commodity j

T_{il} = total time of individual i in the labor market

T_i = total disposable time of individual i

X_j = market goods input into commodity j

x_j = market goods input into one unit of commodity j

E_i = education of individual i

W_i = wage rate of individual i

π_j = full price of commodity j

A_{ij} = $t_{ij}W_i/\pi_j$, share of the value of i's time in the full price of commodity j

i = f, m: wife, husband,

j = n, s

p = price of market goods

V = non labour or non earned income

I = full income

The basic equations are:

(1) $U(c, s) = U(nq, s) = U(n, s)$

(2) $n = g_n(T_{fn}, T_{mn}, X_n)$

(3) $s = g_s(T_{fs}, T_{ms}, X_s)$

(4) $T_{in} + T_{is} + T_{il} = T_i$

(5) $V + T_{ml}W_m + T_{fl}W_f = p(Xn + Xs)$

(6) $I = (t_{fn}W_f + t_{mn}W_m + px_n)n + (t_{fs}W_f + t_{ms}W_m + px_s)s$

(7) $I = W_fT_f + W_mT_m + V = \pi_n n + \pi_s s$

Equation 1 says that parents derive utility from both children services and standard of living. However, given that q, quality per child, is a constant, U can be expressed as a function of n and s alone. This facilitates the analysis as it permit us to obtain the demand for n. Equations 2 and 3 are the homogeneous production functions for children of a given quality (n) and for standard of living (s). Equations 4 and 5 define the time and monetary constraints respectively. Equations 6 and 7 show the full income constraint. Full income is defined as the sum of the volume of produced commodities valued at their full prices (6), or as the sum of non-earned income plus the total disposable time of each spouse valued at its shadow price (the market wage) as in equation 7. Equations 6 and 7 show the equality between full income in expenditure terms and in income terms.

Maximizing utility subject to the full income constraint, or to both the time and monetary income constraints, leads to the following demand function.

$$(8)\ n_o = f(\pi_n, \pi_s, I) = f(px_n, px_s, W_f, W_m, V)$$

That is, the quantity demanded of children of a given quality (hereafter, called the demand for children and denoted by n_o) is a function of π_n, the full price of children, π_s, the full price of the standard of living, and I, full income. However, π_n, π_s, I are endogenous variables which depend on px_n, px_s, W_f, W_m, and V.

The first simple proposition of this model is a well-known one: a rise in the relative price of market goods used to produce children will raise the full price of children relative to the full price of the standard of living, thus leading to a decrease in the quantity of children demanded. If we assume that goods used in the production of children are the same as goods used in the production of standard of living, then an increase in the relative price of goods in terms of time will induce a relative increase in the price of standard of living, thus increasing the demand for children (n_o) and reducing the demand for standard of living (s). It is worth noting that this is a result derived from the Stolper-Samuelson theorem, which establishes a one to one corespondence between factor price ratios and commodity price ratios, when both production functions are homogeneous and the factor intensities of both commodities are different.

In order to analyze the effects of increases in the wage rate and in non-earned income, we differentiate totally (8) with respect to W_i, which leads to the following expression :

$$(9)\ en_ow_i = e^*n_o\pi_n(A_{in} - A_{is}) + (T_{i1}W_i/I)en_{oI}$$

where en_ow_i is the uncompensated wage rate elasticity of the demand for children of constant quality (hereafter called children); $e^*n_o\pi_n$ is the income compensated price elasticity of demand for children; A_{in} is the share of the value of time of individual i in the full price of n (children); A_{is} is the respective share of the value of time in the full price of s (standard of living); $(T_{i1}W_i/I)$ is the share of the market wage earnings of individual i in full income; and, finally, en_{oI} is the full income elasticity of the demand for children.

The effect of an increase in the wage rate of individual i on fertility depends on the difference in time intensities allocated to each of both commodities, the share of the monetary income of the individual in household full income, and the sign of the full-income elasticity of the demand for children. In the case of the mother, it is usually assumed that A_{fn} is greater than A_{fs}, thus the first expression on the right hand side of the equation becomes negative, because the income compensated price elasticity, which is a pure substitution effect, must be negative. $e^{*}n_{o}\pi_{n}$ which is negative, times a positive difference between A_{fn} and A_{fs}, results in a negative first term overall. The assumption that A_{fn} is greater than A_{fs} follows from the assumption that children are mother's time intensive relative to the standard of living. Assuming that children quantity is a normal good, although with a very low income elasticity, and that the mother's monetary income does not have a great share in full income, the conclusion is that a rise in the market wage of the mother, by raising the opportunity cost of child-rearing, will reduce fertility (Schultz, 1981). In the case of the male, the situation will likely be the opposite. In fact, the share of the value of the male's time in the full price of s should be greater than in the full price of n. As well, the share of his market earnings in full household income is traditionally greater than the respective female share (Schultz, 1981). However, the effect of a rise in the male wage rate can also be considered ambiguous (Ben-Porath, 1973). Indeed, $(A_{mn}-A_{ms})$ can be negative or positive, given the very limited amount of time typically allocated by the man to home production; and the full income elasticity of the demand for children can be very small.

Finally, an increase in non-earned income or wealth produces only an income effect, and with children being normal goods, fertility increases. This is due to the fact that non-earned income does not affect the full prices of both commodities (see equation 6).

The previous analysis can be extended to analyze the role of education. This is done by considering the wage rate as a positive function of education. The conclusions reached are very similar to the ones above associated with wage rate changes. The only difference is given by the magnitude of the wage elasticity with respect to education. If this latter elasticity is very low, education will have little impact on fertility and vice versa. The causal mechanism in affecting fertility is the same as in the wage rate case.

3.3 The Connection with Income Distribution

The microeconomic explanations of the role of income distribution on fertility are based on several elements: the possibility of factor intensity reversals in the production of children related to the level of income (Gronau, 1977); different elasticities of substitution between mother's time in child-rearing and market goods at different income levels

(Ben-Porath, 1973; Rosenzweig, 1981); the interaction between quantity and quality of children (Becker, 1973); the earnings of and related interactions between husband and wife (Willis, 1973); and the reversal in the sign of the income effect related with the level of income (Gregory, 1976).

3.3.1 Factor Intensity Reversals and Substitutes for Child Rearing

Gronau (1977) analyzes fertility by examining the effects of children on the mother's allocation of time, hence, reversing the usual analysis of fertility. His basic contentions are that children are home-intensively produced only when they are very little--for example, up to the first year of age, but later on their production can become market-goods intensive. A rise in the shadow price of the mother's time raises the relative price of children only when they are home-intensively produced--that is, when they are produced via a technology intensive in goods produced by the mother's time. When children are market-goods intensive, a rise in the price of mother's time implies a relative fall in the price of the market-goods intensive commodity, and thus the price of children falls in this case (the price of time rises relative to the price of market goods). Finally, Gronau contends that children of richer wives are more market-goods intensive than the children of poor wives. In other words, children of rich families are market-goods intensive and children of poor families are home-goods intensive. Given this, an increase in the mother's wage, and thus in household income, will expand fertility in the case of rich households and lower fertility in the case of poor households.

A similar contention relates to the availability of suitable substitutes for the mother's time. Indeed, Gronau posits that the tendency to replace the mother's time with market-substitutes rises with the wage rate (or the potential wage rate). That is, for mothers with a great endowment of human capital, it becomes unprofitable to produce children with an intensive house-goods technology.

Certainly the previous argument can be extended to the level of household income. That is, for household with a high level of income, the relative cost of domestic services, for instance, can be negligible in relation to its income. That would be especially the case for richer households in LDCs, where a situation of labor-surplus exists (Rosenzweig, 1976). It must be noticed, however, that this argument for the LDCs can be reversed. Indeed, in poor LDC households with high fertility, the older children can be the mother's time substitutes. Therefore, children of poor families, contrary to children of middle-class households, should not be considered time-intensive in their production. Thus, increases in the wage rate for poor wives should expand fertility, while the opposite is true in the case of middle class families. In any event, the result, even though ambiguous with respect to the direction of the income distribution effect on fertility, is that income distribution matters (Rosenzweig, 1976, 1981; Birdsall, 1981).

Willis (1973) opposes the argument that children are market-goods intensive. Willis posits that the number of children is, everything else constant, directly related to the shadow-value of the mother's time. Thus, he argues that the assumption of children as market-goods intensive is counterfactual since the participation rate in the market labor-force is lower for mothers with a greater number of children than for mothers with a smaller number of children. However, his contention, which corresponds to his very restrictive model, can hide more simple facts, such as those suggested by Gronau (1977), and Gupta (1982). A greater number of children may simply reduce the possibility of work in the market. In addition, the shadow value of the mother's time may not rise directly with the number of children.

3.3.2 The Earnings Interaction of Husband and Wife

In general, the microeconomic approach to fertility applies in the case where the wife is working or plans to work. However, certainly there is no relevant opportunity cost at all for a wife whose valuation of time is far above the market wage rate. This is the central point in the Willis model: the distinction between working and non-working wives.

According to Willis (1973), a rise in the husband's earnings or in non-earned income, raises the shadow price of the time of the non-working wife. In fact, the increase in the husband's earnings increases the supply of market-goods used in the production of children and standard of living. Given that the wife's input of time in household production is fixed if she does not work, this results in an increase in the relative price of children, which uses the mother's time more intensively (Rybczynsky theorem). On the other hand, with a one to one correspondence between the ratio of the price of goods and the price-ratio of productive factors, the shadow price of the mother's time also increases (Stolper-Samuelson theorem).[1] A predictable corollary of this is that wives married to wealthy husbands are unlikely to work in the market (Willis, 1973).

In the case of working wives, who are flexible with respect to how many hours they supply in the market, a rise in husband's income will imply only an income effect. In fact, a rise in the supply of goods in the household raises the value of time of the wife's work at home. However, she will reallocate hours from the market to the home in order to equalize the marginal productivities of the last hour in the market with the last hour of work at home. As a result, the shadow price of time remains equal to the wage rate.

---

[1] The Willis Model can be viewed as an application of the theory of international trade to the analysis of fertility. Both the Rybczynsky and the Stolper-Samuelson theorems, and how they are used here, can be better understood by analyzing the Hecksher-Ohlin model of trade. See, for example, Markusen and Melvin (1983).

The proposition of the general model that a rise in the working wife's wage rate (or in her education) raises the opportunity cost of children remains in the Willis formulation.

The pattern of interaction depicted by the model is as follows. Increases in the husband's income affects fertility in different ways depending on the working status of his wife. On the other hand, the working status of the wife is determined by the husband's income. Husbands with high income tend to be married to non-working wives and husbands with lower income to working wives. As a result of this, how either an increase in the market wage rate of the wife or an increase in the wage rate of the husband will affect fertility depends on the level of the other spouse's wage.

The interactive pattern of the model implies a non-linear relationship between household income and fertility. However, the form of this relationship is not clearly indicated by the model. Hence, the impact of income distribution on fertility is ambiguous. Willis (1973) demonstrated that this relationship is an U-shaped one for the United States, and Ben-Porath(1973) obtained the same result for Israel. However, the latter author discusses the Willis interpretation, arguing that the result must be due to the possibility of factor-intensity reversals, or to the relatively cheaper availability of mother's time substitutes for rich people, rather than to the questionable effect of the husband's earnings on the opportunity cost of children

(Schultz, 1981; Ben-Porath, 1973; Rosenzweig, 1981; Willis, 1978).

3.3.3 Quality and Quantity of Children and Their Interaction

Recent developments in the modeling of fertility make a distinction between the quantity and the quality of children. The quality of children is defined as the endowment of goods provided to the child by his parents. The quantity of children is defined as the number of children. Parents are biased towards children-quality, in an analogous way as consumers are biased towards quality in durable goods, such as cars. As a consequence, the quality income elasticity is greater than the respective quantity elasticity. Therefore, an increase in income might increase both quantity and quality, but more so the latter. The effect on quantity is, in fact, ambiguous; it could rise or even decrease (Becker, 1973).

Three important issues must be mentioned with respect to this distinction between quality and quantity. The first is concerned with the apparent contradiction posed by rich families having fewer children than poor families--in spite of the assumed normality of children. This could be explained by the quality bias. The second point relates to the fact that this bias to quality can be interpreted as an endogenous rise in the cost of children with respect to income. Becker, however, contends that parents are free to choose among a wide range of qualities, or different prices of children (Sanderson, 1978; Simon, 1960). The third issue involves the interaction between quantity and quality which leads to the following approach.

The prices of quality and quantity are dependent on income, and interdependent. As a consequence of this, the substitution of quality for quantity is theoretically granted; and the choice between quantity and quality becomes a trade-off. Finally, it can be hypothesized that the substitution away from children quantity must be greater in the case of the poor than of the rich in response to a similar amount of income increase for both (Becker and Lewis, 1973).

These assertions are explained using the following model:

(1) $U= U(c, s)$

$n=$ children quantity

$q=$ children quality

$s=$ standard of living

$c=$ children services $= nq$

(2) $I= nq\pi_c + s\pi_s$

$I=$ full income

$\pi_n=$ shadow price of children quantity

$\pi_q=$ shadow price of children quality

$\pi_c=$ shadow price of child services

$\pi_s=$ shadow price of standard of living

Equation 1, as in the general model, says that parents derive utility from the two commodities: children services and standard of living. Equation 2 is the budget constraint. That is, full income is equal to the volume of produced commodities valued at their full prices. However, differently from the constraint in the previous general model, children quality (q) is allowed to vary. As a result of this modification in the budget constraint, the shadow prices for both children quality and children quality can be derived. Indeed, after the maximization process, it becomes clear that:

$$\lambda q \pi_c = \lambda \pi_n \quad \text{and} \quad \lambda n \pi_c = \lambda \pi_q$$

Thus, the shadow price of children quantity is equal to the shadow price of children services times quality, and the shadow price of quality would be the reverse: π_c times quantity. This implies a trade-off between quantity and quality. That is, the higher the quality desired, the lesser would be the quantity required in order to reduce the shadow price of the former. In other words, the higher quantity a family has, the more expensive it would be to achieve a desired quality and vice versa.

Assuming that rich and poor people receive an equal increase of income, and that the income elasticity for quality is the same for both groups, it can be demonstrated that the poor will face a higher price of quantity if they attempt to achieve proportionally the same increase in quality as the rich. This would be so because the poor must incur a higher expenditure in quality if they want to achieve that same proportional increase in quality

(Rosenzweig, 1981).

Furthermore, policies aimed at reducing the shadow price of quality relative to that of quantity--for instance, free education--will stress the substitution away from quantity. The initial effect in raising quality demand related to the decline in the relative price of quality will induce a further rise in the quantity price. In addition, these policies affect basically the poor--free education at basic levels would not necessarily affect the quality demand of the rich in less developed countries. Thus, a better income distribution reflecting this situation should reduce aggregate fertility.

4. DETERMINANTS OF FERTILITY IN THE CONTEXT OF THE INEQUALITY-DEVELOPMENT RELATIONSHIP

The purpose of this chapter is to provide a developmental interpretation of the relationships between aggregate fertility in LDCs and its most important determinants, emphasizing the interplay between income inequality and these determinants. The exposition that follows is organized in five sections, wherein are examined: the relationships between rational behavior, income inequality and fertility; the role of education which goes beyond the value of time explanation; the existence of possible connections between female participation and inequality; the relationship between inequality and mortality; and, finally, the supply-demand interpretation of fertility.

4.1 Rationality and Inequality

The rational behavior of parents in LDCs can be doubted when considering the apparent lack of reality of some of the corollaries and assumptions that rationality implies--for instance, the perfect control and spacing of births, the household as a decision unit, and the requirements of a minimal set of information in order to make such rational decisions. Furthermore, the existence of important lags in fertility decline in relation to increases in income, decreases in infant mortality, and changes in other fertility determinants would seem to confirm to some extent the weakness of the rationality assumption (Oeschly and Dudley, 1975; Lindert, 1980).[2]

This apparent insensitiveness of fertility decline to development is illustrated in Tables 4-1 and 4-2. In Table 4-1 it is worth noting the narrow differences of fertility among countries with strong differences in development indexes. Finally, the considerable lag of fertility reduction behind decreases in the death rate can be appreciated in Table 4-2.

On the other hand, the rationality of parents in LDCs can be understood as a response of poor people to their deprived conditions, where basically the existence of a pension motive and/or the fact that children constitute income sources for their parents would be the main justification for the assumption of rationality (Williams, 1980; Birdsall, 1977).

Actually, there are good reasons both to doubt and to accept the "rationality" assumption; however, the puzzle that fertility presents for rationality is related to the

---

[2] This sort of a pessimistic view concerning an economic approach to explain fertility in less developed countries would also have some empirical support. For instance, Kuznets (1974) did not find any statistically significant relation between fertility and its traditional determinants, when analyzing a sample of less developed countries. Furthermore, Easterlin (1976) and Mauldin and Berelson (1978) have provided some evidence to doubt whether parents act consciously to control fertility in LDCs. Finally, the adduced increase in contraceptive use by women has been interpreted by many scholars as a substitution of old fertility regulation methods by new and more safe techniques, but both tending to keep under control some socially determined fertility level, not basically different from that of previous stages of development (De Tray, 1976).

Table 4-1

The Insensitivity of Fertility with respect to Development.

(Selected Sample of Less Developed Countries)

Countries	CBR 1960	CBR 1970	GNP 1970	Literacy Rate 1960 (%)	Literacy Rate 1970 (%)	Urbanization 1960 (%)	Urbanization 1970 (%)
Bangladesh	47	44	130	-	10	5	12
Kenya	55	48	150	-	30	7	10
Nicaragua	51	41	430	51	57	41	46
Philippines	47	42	210	-	72	30	32
Colombia	47	44	240	61	68	45	56
Brazil	43	38	420	61	68	45	56
Venezuela	46	40	980	65	77	67	76

CBR refers to crude birth rate.

GNP refers to national income in 1970 (dollars U.S.).

Sources: World Bank Tables 1976, World Bank Atlas 1972.

Table 4-2

The Lag of Fertility with respect to Mortality

(Cases of Taiwan and Mexico)

Country	Year	Crude Birth Rate	Crude Death Rate
Taiwan	1920-24	42	26
	1925-29	44	23
	1930-34	46	21
	1935-39	45	20
	1940-44	42	18
	1945-49	40	15
	1950-54	46	10
	1955-59	43	8
	1960-64	37	6
	1973	23	5
Mexico	1925-29	44	27
	1935-39	43	23
	1940-44	44	22
	1945-49	44	18
	1950-54	45	15
	1955-59	45	12
	1973	46	8

Source: Reproduced from Easterlin (1976, pp. 9-10).

delay in passing from a high fertility response to a lower one when economic conditions in society are changing.

Such a lag in fertility reduction has been interpreted according to three main hypotheses. The threshold hypothesis of economic consciousness (Rich, 1973) implies that before a threshold point, related with a minimal development level or income level, parents would be guided by attitudinal inertia and thus would not practice any fertility regulation, either because they did not perceive the reasons to reduce fertility or simply they did not behave rationally. A second hypothesis, associated with Easterlin (1976), would explain the fertility lag as an unperceived rise in fecundity due to development (better income); this means that fertility will continue to be supply determined until a certain stage of the development process. Finally, the third hypothesis would be that the relative cost of children to goods would not rise until further advance of the development process.

Income inequality, however, can provide a more general explanation of the apparent contradiction between a lack of rationality suggested by the fertility lag and the presence of it sugested by the pension motive. Moreover, the inequality explanation would be related to the previous three hypotheses. In fact, rationality concerning fertility determination can be as dualistic as is the pattern of economic development of the society. In a typical LDC there may coexist social groups that present different rational behaviours: one of high fertility and one of low fertility, each being inversely related with the average welfare of each group. Certainly, the relative cost of children will be inversely related with such a behavior of high or low fertility. Indeed, those groups which lag behind the spread of benefits of development (namely: education, income, health improvements, etc.) would have no reason to alter their behaviour of high fertility. Further, several researchers have suggested that the relative price of children, faced by some groups within the society, may even decline at the earliest stages of economic development. That would be the case, for instance, with peasants. In fact, the process of internal migration to the cities, especially of young females, would reduce the price of children faced by the peasants. As well, an exogenous fall in infant mortality can also be interpreted as a fall in the price of children (Boserup, 1970; McCabe and Rosenzweig, 1976; Lindert, 1980). The consequence of this should be an increase in fertility of some societal groups.[3] On the other hand, those sectors which are incorporated into the development process certainly will have good reasons for reducing fertility, such as higher oportunity costs, social welfare systems, among other reasons.[4] Therefore, to the extent that the development process is accompanied by a high degree of inequality, implying that an extensive part of the population remains without significant change in its socio-economic conditions, it follows that the fertility decline of the whole society will be very small or non-existent or that fertility may even increase.

---

[3] A lower net price of children caused by a decline in infant mortality, when income sources for children work are still present, or even in expansion, as in the first stages of development, should imply an increase in fertility if parents behave rationally (Lindert, 1980).

[4] The net cost of children rises during the development process. This occurs mainly because the sources for children's income tend to disappear, and because the reasons for the pension motive become weaker (Mueller, 1972; Repetto, 1976; Lindert, 1980; Williams, 1976). The decline

This latter hypothesis provides, perhaps, a better explanation for the fertility lag than the threshold hypothesis. Certainly the coexistence of two such rationalities, and finally the predominance of one of them, will depend to a great extent on the income distribution. In the same fashion, the lag in the rise of the relative cost of children with respect to the development process is also compatible with an income-inequality explanation. As suggested before, to the extent that large groups of the population remain in the backward agricultural sector or in marginality conditions in the cities (thus outside the schooling system and social-security advances), they will probably not experience a rise in the relative cost of children. Further, to the extent that there are sources for

---

'(cont'd) in children income sources is explained by the transition from agricultural to industrial and urban stages, where work for children becomes scarce. In addition, the process of compulsory education and laws against children's work which usually accompanies development militates against child labor. An additional source of rise in cost which accompanies this is the fact that both space for living and food tend to be more expensive in cities than in the country side. The necessity for children to look after parents in their old age decreases for several reasons: the increase in income itself, the development of welfare institutions, the destruction of the extended family system; and the higher reliance of parents on the their own means for surviving, when a higher education and income is achieved.

children's work and a possibility of eliminating the surplus labour in farms through internal migration to the cities, the cost of children will decline for some groups of the population.

An illustration of our hypothesis is suggested by inspecting Table 4-3. For instance, in 1969 Ecuador had an income 2.9 times that of Bangladesh, but because both have 58% of their population living under the poverty line of U.S $75, it is more understandable that their crude birth rates were nearly the same in 1969-70. The same argument can be applied partly to explain the narrow differences between the fertility levels of Ecuador, Tanzania, and Kenya.

The previous kind of economic argument, however, can not explain totally the lag of fertility behind development; indeed, it would be a very mechanical explanation. Actually, such a lag may reflect also a cultural or anthropological situation. That is, changes in economic conditions, specifically a rise in the net cost of children, do not imply a one to one change in attitudes and societal norms required to support the fertility decline. In fact, these norms and attitudes have developed slowly over time, as a rational response to poverty or backwardness. However, they can not change as fast as rapid economic development occurs. An indirect confirmation of this latter point comes from the fact that the fertility lag is longer among recently modernizing less developed countries than earlier developing ones. This suggests that the faster rate of economic change

Table 4-3

The Relationship Between Absolute Poverty and Fertility

Country	Percentage of Population bellow U.S. $75 (1969)	Crude Birth Rate 1969-70	GNP per Head 1970
Tanzania	73%	47	100
Kenya	-	48	150
Bangladesh	58%	44	100
Ecuador	58.5%	45	290

Sources: Poverty data in Ahluwalia and Chenery, 1974; crude birth rates from World Tables, 1976; and GNP per head from World Atlas, 1972.

which has been ocurring in the former nations would have required an even faster speed of attitudinal changes (Lindert, 1980; Caldwell, 1976; Davis, 1963).

Income distribution is positively related to the fertility lag. That is, geater equality or improved income distribution implies the successive exposure of those backward and traditional groups to progress and to a modern way of life. Such an exposure, in turn, will be determinant in producing the required attitudinal changes and the correct perception of new costs and opportunities, leading to a decline in the fertility level of the poor (Rich, 1973; Kocher, 1973; Freedman, 1976; Birdsall, 1977).

4.2 Education and Inequality

Certainly, the consideration of education, when analyzing the inequality role in fertility, is valid to the extent that both phenomena should be inherently related in the long run (Simon, 1974, 1976). It must be said, however, that the indirect effect of an improvement in income distribution on fertility, through a better education, operates only via an increase in the absolute level of income of the poor. That is, income distribution has no autonomous effect itself on education, based for instance on a non-linear relationship between the two, as in the previously discussed cases of fertility and life expectancy.

Therefore, the argument that links income inequality, education and fertility is an "income" argument, or what we have called a structural approach.[5] Further, in the empirical model developed later, we do not consider any effect of income distribution on education.

The educational role should not be understood only in its formal aspects; one should also take into account informal education which comes with exposure of the population to progress, and which is determined mainly by change in the structural economic character of society (the step from an agricultural stage to urbanization, or even the step from an agricultural stage to a more highly productive modern agricultural system).

Under this general perspective, it is useful to highlight the following aspects of the role of education: the change of fatalistic attitudes related to poverty; the revolution in aspirations; the development of an independent role for women; the expansion of the information set; and, finally, the increased efficiency in controlling both fertility and mortality--the latter aspect will be analyzed in a separate section (Mueller, 1972; Williams, 1976; Birdsall, 1977).

Fatalistic and pessimistic attitudes towards life are related to a poverty stage, where the people's degree of control over their own decisions and over common events is highly restricted, and therefore all kinds of outcome ruling life are likely attributed to destiny, fatalism and in general, submission (Repetto, 1974, 1976, 1979). Education to a great extent breaks this situation, giving to the poor a higher self-confidence in the possibility of managing their circumstances. The connection of this with fertility is through the weakening of the pension motive, and through a greater perception of costs and opportunities related to development or greater equality. In fact, the evidence on this point comes mainly from attitudinal studies (Repetto, 1976; Mueller, 1976) which show, generally speaking, such higher perception of costs and opportunities, and the consequent decline in the pension motive.

---

[5] Notice that a more pure relation between these variables could be justified provided that education, itself, has a non-linear relationship with fertility. That is, basic education, or a few years of education, reduces fertility by more than higher years of education (Ben-Porath, 1973). Thus, to the extent that an improvement in income distribution determines an improvement in the basic education of the poor, the final effect should be a reduction in aggregate fertility.

Aspirations in life, concerning a desired better standard of living and opportunities either for parents or for their children, are also transformed by education. In her study of the Taiwan population, Mueller (1976) reports that the aspirations of parents for their children tend to rise dramatically with education (Birdsall, 1977, 1980; Williams, 1976). The connection with fertility can be better understood by considering the expansion of the informational set, which is required to substitute quality of children for quantity. Such an expanded information set is an unrealistic assumption of Becker's approach when considering the reality of less developed societies. Becker postulates that everyone in society knows the different qualities of children available in the market. Certainly, in less developed societies most of the people, especially the poor, live in a world of very restricted information. In relation to fertility, this means that poor people do not really know the difference between quality and quantity.

A second way in which improved education acts is simply by affecting tastes against children. The aspirations for a higher standard of living, and particularly the change in consumption patterns associated partly with demonstration effects, are likely to be stronger in a society which is breaking with its dualistic characteristics of having both backward and modern people. Such forces can act powerfully against fertility to the extent that the poor realize that children quantity is an obstacle to achieve a minimal desired standard of living (Freedman, 1976).

The educational role seems to be particularly important in the case of women. An increase in a woman's education acts through different channels affecting fertility, the most important being that of the gain of her right to be considered a person, and therefore her increased involvement in important household decisions, including those relating to fertility. Since the woman has been historically placed in an inferior role in many cultures, and yet is the more important actor in the birth process, it is not surprising that her increasing freedom, status, and aspirations will reduce desired fertility (Dixson, 1976; Ryan, 1952; Mitchell, 1972).

However, the educational role of women in reducing fertility must be considered with some qualifications. First, such an effect tends to be stronger when the woman is involved in activities outside the home and especially in the modern labor force. Second, the effect is highly dependent on the cultural characteristics of the society; for instance, the Muslim culture discourages female activity outside the home (Dixson, 1976; Kirk, 1966; Anker, 1978).

4.3 Female Participation Rate and Inequality

The traditional economic analysis of fertility, or the value of time approach, has considered the female participation rate as a variable which acts inversely on fertility (De Tray, 1976; Michael, 1976; Schultz, 1980, 1981). Such an analysis assumes that the female participation rate proxies the opportunity cost of children. That is, the female participation rate has a direct relationship with the wage rate; and a rise in the female wage rate constitutes basically a substitution effect on the consumption of children. Certainly, the whole of this analysis assumes that the mother's work in the market is totally incompatible with child rearing activities.[1] However, the reality for some of the LDCs, particularly the least developed, is that much of the market work done by the mother is compatible with child-rearing. Further, the high fertility in those countries implies the availability of free substitutes for the mother's time--older children--which facilitates the mother's participation in the labor force. Therefore, in these conditions, a rise in the female wage rate may constitute only an income effect on the consumption of children. Thus, the relationship between the female participation rate and fertility could be positive in the earliest stages of development (Rosenzweig and McCabe, 1976; Kasarda, 1971).

---

[1] For details of this analysis refer to Chapter 3.

Actually, the empirical evidence has shown more support for a negative relationship than for a positive relationship between these two variables (Birdsall, 1977; Williams, 1976). The issue, however, remains open. In fact, most of the research on the subject has used samples constituted by a combination of developed and less developed countries. Further, the data for the female participation rate are generally biased, capturing mainly that kind of female work which is incompatible with child rearing (Schultz, 1981). Thus, some of the evidence on the negative relation between these two variables may reflect partly this latter situation. On the other hand, there is a high possibility that a positive relationship between the female participation rate and fertility takes place only in a very few backward nations, and thus it is not captured in more representative studies of LDCs.

In conclusion, it is not surprising to find a negative relationship between these two variables in LDCs studies. Probably such findings reflect the most representative relationship between the female participation rate and fertility in LDCs. An additional assertion is that the magnitude of the effect of the female participation rate on fertility, though negative, may be weaker in LDCs than in developed countries (Birdsall, 1977).[7]

Searching for a connection between rate of female participation in the labor force (hereafter FPL) and income distribution in LDCs, we must analyze the principal hypotheses concerning an explanation of female participation: first, the inverse relation between household income and the FPL; second, the structural explanation relating the FPL level to the type of economic activity predominating in the country; and third, the cultural factors determining female participation.

The first hypothesis postulates an inverse relationship between household income, or the husband's income, and the FPL. In LDCs, the wife must work in the market when household income is very low in order to complement it and thus achieve a minimal subsistence level for the family. In so doing, she must decline apparently more "productive activities at home" such as child rearing (Schultz, 1980). However, when income rises, the complementary income provided by the mother will lose importance and she could return to the household's priority of child rearing. Nevertheless, it might be expected that at higher levels of income the FPL would rise again and then finally decline.

---

[7] The opportunity cost associated with children in developed countries must be higher than in less developed countries.

The explanation for this is that the first adduced hypothesis of FPL declining with income would make sense for only a limited range of income increase. The reality would be more compatible with a U shaped aggregate relationship between FPL and development or income. (See Table 4.4 at the end of the chapter).

Actually, the likely evolution of the FPL over time is complicated to explain. First, the decline in the FPL caused by an increase in household income implies that the husband's income increase must be sufficiently important to allow the retirement of the woman from the labor force. It is almost certain that her wage rate will lag behind the husband's within a certain range of the development process. In terms of a value-of-time explanation, it would mean that the woman's value of time rises above the market wage at a certain stage of development, and certainly this is compatible with the previous aspect of a rise in husband's income. Secondly, the wife's allocation of time fully to the household cannot be prolonged if the income stage of the household is not very high, since there will again come a time, due to development, when a great part of the household activities of the wife would have less comparative advantage than being in the market. For example, it would be less productive to make the family's clothes than to buy them, and thus the opportunity cost of home activities will begin to rise. Moreover, if home activities can be seen as having economies of scale in the joint production of goods with child rearing, then as a consequence women will be induced again in the labor force in order to trade their labor for goods (Schultz, 1981). However, higher up in the income scale, the valuation of time by rich women would almost always be above the wage rate movements indicated by the labor market, which for our purposes means non-participation of women in the labor force. This explanation would suggest that the female participation rate would be non-linearly related with income, if we allow at the same time the variation in the value of time. Thus, income distribution will somehow affect FPL, although it is not possible to specify the sign of this effect.

The structural hypothesis is stronger and more clear cut in explaining the female participation rate. In fact, this hypothesis states that the FPL depends on the type of predominant economic activity. If the latter is predominantly one of agriculture, women would have much more chance, like children, to become engaged in the labor force. If the type of predominant activity is one of industrialization and associated with urbanization, then women would see their more important source of work destroyed (United Nations, 1981). Certainly, this hypothesis takes account of the aggregate FPL; indeed, the process of development can be viewed as having dualistic characteristics concerning the FPL. On the one hand, development increases the demand for skilled women in the industrial sector and in the services sector; on the other hand, it reduces that for more unskilled women, who are the majority.

Finally, the cultural hypothesis simply reflects the fact that some cultures encourage and others discourage female engagement in activities outside the home, this phenomenon being particular to the less-developed world. As we mentioned before, the Muslim culture is a clear example of discouragement (Dixson, 1976) and probably the Asian cultures would be an example of the opposite case.

The following conclusions respecting the relationship of income-inequality and the FPL can be stated. There is no certain relation between income inequality and the FPL. If we assume a general point of view, considering that poor wives must work and after a certain level of income women do not work at all, then it could be said that a worse income distribution could likely imply a higher FPL, and vice versa. If we assume an explanation comparing home productivity with market place productivity in a development context, the FPL-income relation could be thought as non-linear with the FPL decreasing during a range of income increase, increasing thereafter and finally declining. Nevertheless, the effect of income inequality on the female participation rate would be ambiguous, sometimes being positive, sometimes negative and sometimes zero if we observed these movements in a sample of countries. Finally, if we assume a structural point of view, it could be speculated that a higher degree of inequality could be

Table 4-4

Relationships Among Female Participation Rate, Development, Agricultural Stage and Crude Birth Rate

(Circa 1970)

Countries by Income Level	Female Part. Rate 1970	% of Labour Force in Agriculture 1970	Crude Birth Rate 1970
Bellow US $100	35.6	76.9	44.9
US$ 101-200	23.2	66.3	48.2
US$ 201-375	21.6	54.0	37.6
US$ 376-1000	23.7	38.1	32.9
Above US$ 1001	32.4	11.7	17.1

Source: Data compiled by the author from World Bank, World Tables 1976, pp. 508, 516, and 517.

related with the existence of an important backward agricultural sector, and therefore with a higher FPL. However, if we control this latter factor, we could find that a better income distribution at the agricultural stage could have different and opposite effects.

In Table 4-4 there are illustrated the relationships among level of development, the female participation rate in the labor force, the crude birth rate, and the female participation in the agricultural labor force. A visual inspection of the data reinforces the hypotheses of a non-linear relation between the FPL and the level of development, and the positive relation between FPL and an agricultural stage of development.

4.4 Infant Mortality and Life Expectancy

Paul Schultz has convincingly argued that fertility in less developed coutries should be considered as a demand for survivors, explain~~ing~~ in this way the positive relationship between fertility and infant mortality commonly found in cross country studies (Schultz, 1976, 1980, 1981; Birdsall, 1977; Heer, 1966; Weintraub, 1962). The relationship is positive because parents have children with some expectancy of infant mortality, thereby adjusting the number of births to achieve a desired, almost fixed number of survivors.

The effect of both a higher life expectancy and a lower rate of infant mortality is to reduce the net cost of children, and to raise the value of life.[8] In turn, the increase in the certainty of a longer life span, and thus the higher value of children will induce a fertility reduction by inducing a substitution away from quantity toward child quality (Schultz, 1976).[9]

Two positions have been argued to explain the improvement in infant mortality. The first one states that the most important determinants of it are increases in health technology and government intervention (Stolnitz, 1965; Arriaga and Davis, 1969). A second position, which does not exclude consideration of the first, sees mortality as being importantly determined by income, education, calorie intake and other general conditions of the standard of living, which are ultimately related to income (Preston, 1980; Rodgers, 1979; Schultz, 1980).

This second position views mortality as being determined by an exogenous parameter related to government intervention. The slope of the curve relating life expectancy to income is determined by variables related to income. A connection with income distribution is given by the non-linear relationship of mortality decline with income; in fact, income improvements will show diminishing returns in life expectancy. This explanation is reinforced given the causes of death in less-developed countries, which are to a great extent determined by socio-economic conditions. In LDCs, standards of living are poor and diarrhoea and influenza are common as premature causes of death. Moreover, the role of inequality would be reinforced when one considers that the poor generally remain at the margin of government actions, either because of their rural isolation or their status of marginality in cities (Birdsall, 1977).

---

[8] A reduction in the number of child deaths in the family reduces the waste of resources and the average cost of surviving children.

[9] It must be said, however, that an improvement in infant mortality could imply a negative effect on fertility at a low stage of development. Indeed, there is no reason to think that the demand for children must necessarily be price-inelastic when children are still sources of income (Lindert, 1980). Secondarily, a decline in mortality is associated with higher fecundity and, thus, with higher fertility (Easterlin, 1976).

In any case the gains in mortality become marginal after a certain point; for instance, it is fairly easy to abate gross points of mortality by controlling diarrhoea and influenza. It is much more difficult to control systemic diseases such as cancer. A better income distribution, by promoting a better standard of living and better access of the poor to health services, medicine and drugs, etc., would reduce to an important extent the aggregate mortality level of a less developed society. To the extent that this affects fertility without a significant lag, the relation between income inequality and fertility is reinforced.

4.5 Supply and Demand Sides of Fertility, and Inequality

The supply side of fertility can be defined as the potential number of live births surviving a minimal age (suppose 4-5 years of age) that a mother can expect on average. This definition attempts to capture the essence of the supply side definitions of Schultz (1981) and the concept of natural fertility from Easterlin (1976). This potential number can be considered as lower than a biological maximum, because any society can be thought as having a socially defined limit to fertility, achieved either by the social intercourse taboo or other accepted social techniques.

This definition of the supply side deals both with fecundity and infant mortality. In this way, it is specifically related with development. In the initial stages of development, there is an improvement in the nutrition and health conditions of the mother which can increase fecundity and reduce infant mortality. Furthermore, infant mortality would also be reduced by the general rise in living conditions. Therefore, the supply of fertility can be viewed as rising with development until it reaches a level close or equal to the biological maximum fecundity and minimal biological infant mortality.

The demand side of fertility can be viewed as the desired fertility level of the family or, in other words, the number of births carried alive to a certain minimal age, that the family would like to have if it could have a perfect command of fertility regulation. The determinants of desired fertility are those already discussed: education, female participation rate, urbanization, etc. The most logical outcome is that desired fertility declines as development occurs.

4.5.1 Supply and Demand Interaction

Desired fertility is certainly high at low levels of development, when the rationality for having children is clear. However, up to that stage, given the high patterns of infant mortality and a supposed low fecundity, the outcome must be one of excess demand over supply. Certainly, desired fertility can also rise, like supply, in the former stages of development. The rationality for this is related to the reduction in the price of children and the existence of sources of work for children, and thus income, in the early phases of development. After a while, development will result in a reduction in desired fertility, because of the increase in the price of children relative to the prices of goods and because of higher levels of education. At this point, supply and demand will intersect. Finally, in further stages of development, there will be a situation of excess supply.

Therefore, the proposition of this interpretation is that fertility is firstly determined by supply forces, and only after a point of minimal development is it determined by demand forces. Certainly this presents a theoretical problem of identification when studying fertility because it is virtually impossible to differentiate supply from demand in the empirical analysis. Nevertheless, there is no solution to this problem other than assuming fertility to have a non-linear relationship with development, or to study a reduced form where both elements are acting. However, a rescuing element for the empirical analysis is the fact that the supply determination of fertility occurs only in very few backward economies. More interesting than this is the consideration of a "real fertility curve" which is shown in Figure 4-1.

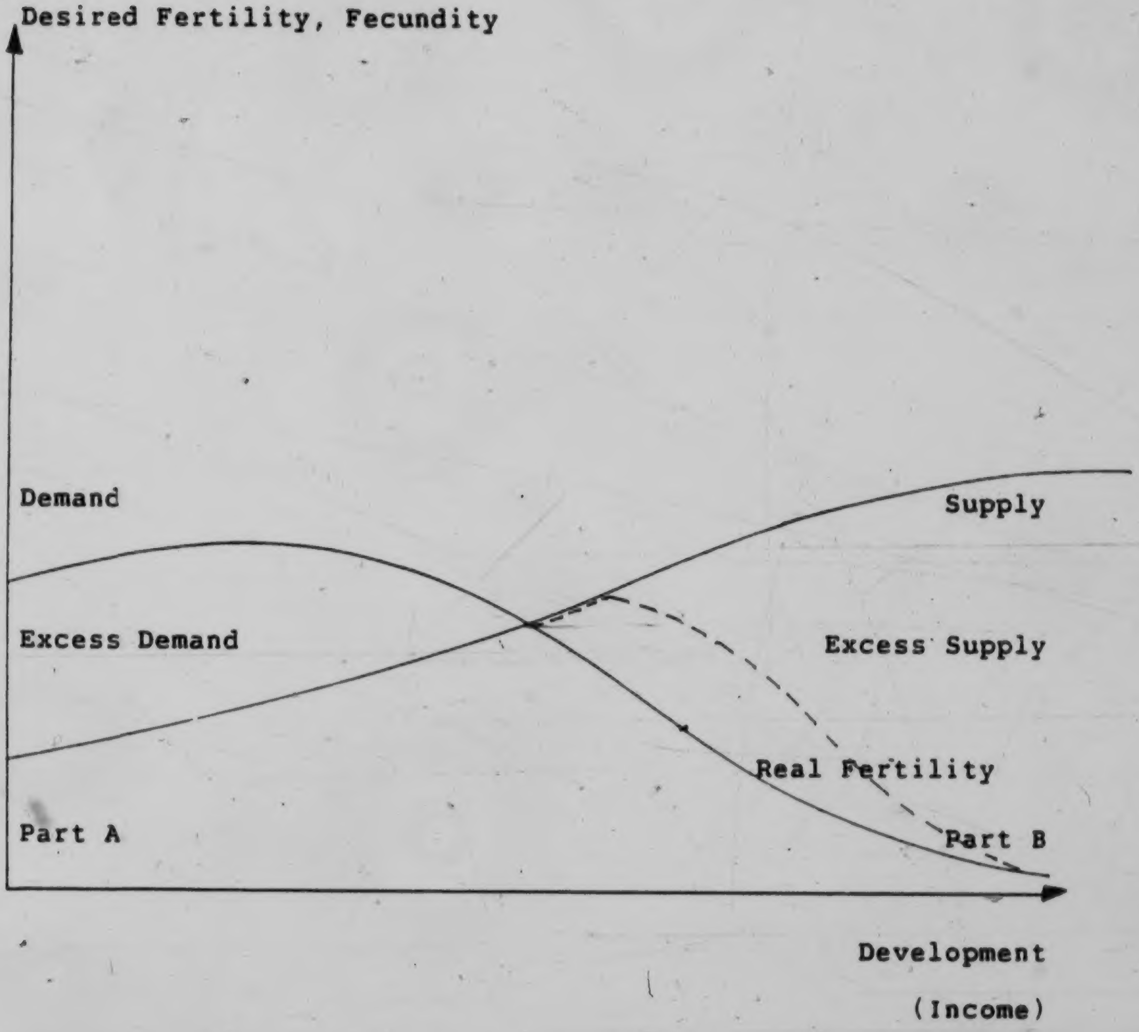
Real fertility is a curve of approximation to desired fertility when the latter is constrained. The existence of this real fertility curve is explained by the lack of an immediate perception of the reduction in desired fertility, the poor efficiency in reducing the supply excess, or another economic mechanism implying, for instance, that the immediate cost of reducing fertility is higher than the immediate benefit of such reduction (example : high relative price of efficient fertility control technology).

4.5.2 The Relationship with Inequality

This explanation of fertility as being supply-demand determined, and the consequent existence of a real solution different at the begining from desired fertility, has several connections with inequality.

A first obvious connection is given by the non-linearity which arises from considering fertility as supply determined at some levels of income, and demand determined at higher levels of income. However, within this perspective, an improvement in income distribution could

Figure 4.1 Interaction between the Demand and the Supply Side of Fertility


Desired Fertility, Fecundity
Demand
Supply
Excess Demand
Excess Supply
Real Fertility
Part A
Part B
Development
(Income)

Source: Repetto (1979).

increase rather than decrease fertility, because it would have a more likely effect on supply.

Nevertheless, more realistic connections arise from considering the relationship between the real solution and desired fertility, after the intersection between supply and demand, which occurs at higher levels of income. Let us suppose that the perception of desired fertility is the correct one, but the difference between the real solution and the latter is explained by the difference between immediate cost and benefits of reducing fertility. Given this situation, an income distribution, favouring the poor, could match that calculation causing an immediate decline in their fertility level, and then in aggregate fertility. The same argument can be explained as the fact than an equal amount of increase in income for rich and poor people, if it is enough to match the difference between the immediate cost and benefit of reducing fertility of the poor, would reduce fertility of the poor more than the rich. (This can also be imagined as a free provision of contaceptive technology for the poor). Let us suppose now that fertility of the poor is at some point on the real fertility curve after its peak, and fertility of the rich is at some point on the desired fertility curve; in this situation, an improvement of the share in income of the poor will also reduce aggregate fertility. Ultimately, in order to avoid already discussed arguments, let us suppose an increase of education of the poor related to a better income distribution. In this case, one can apply the Ben-Porath's argument that the first years of education reduce fertility more than the latter years of education.

5. REVIEW OF THE EMPIRICAL LITERATURE

This chapter presents a critical review of the empirical work done on the inequality-fertility subject. The purpose of doing this is: first, to make clear the most common problems faced in the empirical analysis of the subject; second, to point out the necessary qualifications therein; and, finally, to provide a comparative basis to better understand and judge our own empirical work.

We have made the following classification of the work done in the area. A first group corresponds to what we have called a structural approach to the role of inequality on fertility. This type of work has been done mainly by Rich (1973), Kocher (1973), and Bhattarcharyya (1975). A second group is that which blends the so called direct and indirect approaches; roughly, it combines macro with micro interpretations of the role of inequality on fertility. This type of work has been done mainly by Repetto (1974, 1979) and Flegg (1979). The models used by this group make limited use of the mutual relationships between fertility and its explanatory variables, dismissing the analysis of a more ample and policy-relevant framework of fertility-economic relationships, which should include the link between fertility, income distribution and savings. On these grounds, a third group can be distinguished which analyzes fertility pressures on savings, and thus on economic growth. The effect of improvements in the income distribution is analyzed herein by comparing its consequences on fertility

--the potential benefits of a reduction in fertility--versus its consequences on savings and through this on the rate of economic growth--the potential negative effects. This type of work has been done mainly by Gupta (1975, 1982, 1983). Other authors who have developed this theme are Bilsborrow (1980), Leff (1969), Ram (1982), and Hazledine (1977).

Finally, it must be said that the most important work on the inequality-fertility relationship is based on a simultaneous equation system approach. The works of Flegg and Repetto, which adopt this approach, are based partly in the work of Gregory (1974,1976) and Anker (1978). In the following sections, we will concentrate on discussion of the most representative work done in each area.

5.1 The Structural Empirical Work

The work of Kocher (1973) focused mainly on studying the connection between agriculture development, equality and fertility. He emphasized the role of agricultural development in promoting equality and thereby reducing fertility; his conclusions are reached through a descriptive comparison between two groups of countries, the first set composed of South Korea, Taiwan, Japan and Costa Rica and the second composed of countries such as Mexico and Brazil. His conclusion after a full descriptive analysis is that the first group of countries, in contrast to the second, focussed initially on agricultural development, inducing a more egalitarian structure of land property, and thus a more egalitarian income distribution and a reduction in fertility. Such an outcome could not be achieved by the second group of countries characterised by an extreme pattern of dualistic development.

Rich (1973), based on the assumptions of the threshold hypothesis related to a down-turn of fertility after some critical point of development, attempted to demonstrate that improvements in income distribution will carry the majority of the society faster to that threshold point, thus reducing aggregate fertility more quickly. In his analysis, he showed a special sample of countries comparing the movements in Gini indexes and fertility between two points of time. The countries used were again Taiwan, South Korea, Philippines, Mexico and Brazil. He found that the first two nations which showed an improvement in their Gini coefficients further reduced their fertility rates as opposed to the three latter countries which had worsened their Gini ratios, in spite of having equal or even higher income per-head (see Table 5-1).

These works, in general, have been criticized for the lack of a more formal econometric approach, with the implication that attributing the effect of fertility reduction to inprovements in income distribution would be a biased result (Rosenzweig, 1981; Birdsall, 1977; Oey, 1981). This would occur, it is contended, when important variables such as education, infant mortality, and the female participation in the labor force, among others, which could

Table 5-1

Relation Between Changes in Income Distribution over Time and Fertility

Country	Year	Crude Birth Rate	Average Income (US.$)	Income Improvement of the Poor
South Korea	1960	42	138	20% over last 20 years
	1969	30	242	over 100%
Brazil	1960	41	268	Negligible
	1970	35	348	Negligible
Philippines	1960	45	169	Negligible
	1970	44	208	Negligible
Taiwan	1960	36	176	
	1970	26	334	200%
Mexico	1960	44	441	Negligible
	1969	41	600	Negligible

Source: Reproduced from Rich (1973, p. 71).

have been the main causal variables in such fertility reduction, are not taken into account in the analysis.

Such concerns are strengthened when one inspects some counter examples and studies the atypical nature of the sample of successful and unsuccessful countries in controlling fertility. In fact, Sri Lanka, South Korea and Costa Rica, typically used as examples of the successful group, exhibit, besides improvements in equality, extraordinary general indexes of development and rates of improvement of such indexes, in comparison with what could be expected given their income category. The same argument but in a reverse direction applies to countries such as Brazil generally chosen to demonstrate the unsuccessful case. These cases are illustrated in Table 5.2.

It is worth noting in this table that Sri Lanka, South Korea and Costa Rica exhibit impressive records of lower infant mortality and higher education performance not only with respect to their own income category, but also with respect to the upper middle income countries. Besides this, it is worth noting that Brazil exhibits the inverse picture: extremely poor indexes of development relative to what would be expected given its income category. Finally, there are two interesting counter examples, Colombia and Tanzania. Colombia exhibits a trend to increasing inequality but has managed to achieve one of the highest percentage reductions in the crude birth rate of this sample of countries; Tanzania, on the other hand, has tended to reduce inequality

Table 5-2

The Atypical Character of the Studied Countries and Counter Examples

Country	Infant Mortality			Enrolment Ratio Secondary School			Gini Index		Crude Birth Rate		% decline in CBR
	1960	1970	1980	1960	1970	1980	Different Periods		1960	1980	(60-80)
Tanzania	144	160	98	2%	3%	3%	.47(63)	.35(73)	47	47	.08%
Sri Lanka	71	50	32	27	31	51	.50(63)	.37(70)	36	27	26%
Colombia	93	70	54	12	21	48	.48(62)	.55(70)	47	29	39%
South Korea	78	-	32	27	41	85	.30(68)	.27(71)	43	23	47%
Honduras	145	-	83	81	10	30		.56(68)	51	44	19%
Philippines	106	80	51	26	45	63	.05(60)	.49(71)	47	31	34%
Brazil	118	110	73	11	27	32	.59(60)	.63(70)	43	31	27%
Mexico	91	61	53	11	23	51	.54 (63)	.59(69)	45	34	25%
Costa Rica	74	60	18	21	29	48	52(61)	.44(71)	48	30	37%
Low Y LDCs	165	-	87	7	-	19	-		47	44	72%
Mid. Y LDCs	126	-	114	10	-	34	-	-	46	37	21.2%
Upper Y LDCs	101	-	58	20	-	51	-	-	40	31	23.2%

Sources: World Bank 1976, 1984; Jain, 1975. Number in parentheses are years. Y refers to income.

CBR is the crude birth rate

without achieving any reduction in its crude birth rate in a period of twenty years.

Certainly this illustration does not destroy the attempted explanation of the income distribution role, but certainly highlights the implicit bias in considering, isolated from other variables, the role of income distribution on fertility.

Bhatacharyya (1975), in his empirical work, used an index of rural urban inequality of the following form:

$$R = \frac{UY - RY}{Y}$$

R = index of rural urban inequality

UY = urban income per capita

RY = rural income per capita

Y =income per capita

He built double entry tables, using three categories of income and two of inequality, in order to analyze infant mortality and fertility rates of a sample of 52 countries in 1950. He showed that for each bracket of income, the birth rate and the infant mortality rate were positively related with the degree of inequality.

The criticism of the work of Bhattarcharyya (Flegg, 1979) is quite similar to the previous critique. It is argued that his conclusions are again biased because of the non-consideration of other important determinants of fertility besides income and inequality. Furthermore, Flegg has noticed that, besides the inadequacy of the method, the conclusions are dependent on the arbitrary decision of where to set the limit of the inequality categories, and that the conclusions are not even statiscally significant at the 20% level.

5.2 The Mixed Empirical Work: Direct and Indirect Effects of Income Distribution

Repetto (1979) has done at least three works in the field, which are condensed in his book, Economic Equality and Fertility in Developing Countries. These works have included an analysis, similar to that of Rich, of changes in fertility associated with changes in the Gini coefficients, as well as a more formal econometric approach which will be explained below.

In building a simultaneous three equation model, Repetto (1979) used the fertility rate, income distribution and infant mortality as endogenous variables. Fertility was determined by income per-head, relative income inequality (proxied by the Gini index), the female literacy rate and the infant mortality rate. Income distribution was determined by income per-head, the fertility rate, an index of the dispersion of education, and the share of the smallest 60% of holdings in total agricultural area. Infant mortality was determined by fertility, average caloric intake and the female literacy rate. He used a sample of 68 countries, including 23 developed nations and six socialist ones, with data for the middle sixties.

Repetto claimed to have demonstrated that the income distribution variable was statistically significant in explaining fertility either using the single equation of this latter variable--OLS estimation, or using the whole system--TSLS estimation, with the outcome that the income distribution role was even more important.

Repetto's conclusions are not valid for a sample of less developed countries (Birdsall, 1976; Flegg 1979); in fact, Repetto's results do not follow when the regressions are done in the absence of the developed countries and especially when the socialist countries exhibiting low Ginis and low fertility rates are excluded. A second important error of specification by Repetto is the non-inclusion of the female participation rate in the fertility equation, a fact that can be enough to produce the statistical significance of the income inequality parameter. However, the most important problem in his study is the dependence of the results on the particular sample chosen, which invalidates his conclusions in the case of less developed countries.[10]

Flegg (1979) used a sample of 60 countries disaggregated into 13 developed and 47 underdeveloped nations. He constructed an equation system of two equations: the first, fertility, explained by income per-head ("real" gross domestic product per head), Atkinson's index of inequality, the infant mortality rate, and the percentage of females in the labor force; the second, female participation in the labor force explained by income per head, Atkinson's inequality index, the crude birth rate and three dummy variables to measure cultural, continental and religious influences. His results show that the effect of inequality was positively related with fertility both in a sample of pure less developed countries and in the total sample. The most specific procedural changes used by Flegg include: the use of real income obtained by correction of income per-head using purchasing power parity; the replacement of the Gini index by the Atkinson index of inequality; and, finally, the use of observations of the variables for the specific years for which income distribution data is available, a procedure which means that his cross section analysis uses a sample with a range of observations from 1958 to 1970.

---

[10] As Flegg (1979) has posited "it is clear that Repetto's results are inconsistent owing to the omission of important explanatory variables as the female participation rate". See also Williams (1976), Birdsall (1977) and Schultz (1981) on the relevance of the female participation rate as a determinant of fertility.

Flegg can be criticized on two grounds. The first one is the uncertainty of the relative advantages of using Atkinson's index instead of the Gini index. Certainly the Gini index has the important disadvantage of being capable of representing two Lorenz curves with different normative meanings, besides other problems (Loehr and Powelson, 1981; Dahlby, 1984). However, the derivation of Atkinson's index involves an element of arbitrariness, in terms of the choice of a particular parameter for the degree of inequality aversion of the society. In fact, the value of this parameter chosen by Flegg, equal to 1, might be high enough to "punish" those income distributions concentrated in upper percentiles thus inducing a spurious correlation with fertility. Flegg does not present any reason why he choose 1 instead of 0.5, for instance, nor does he discuss the sensitivity of his results to the choice of this parameter.

A second criticism of Flegg's work is his method of working with the observations concerning the year of available data for income distribution. This procedure involves the application of a cross section analysis to countries observed in a somewhat wide range of years. Naturally this process would not present anything wrong if there were not doubts relating to the possibility of important shifts in the analysed functions. However, as Birdsall (1976) and Preston (1976) have pointed out, the fertility function and the mortality function have been shifting in position. In the case of fertility, this shift has occurred for each bracket of income, education, and female participation rate. Therefore, this being the case, the conclusions of Flegg may be biased, exaggerating the real inpact of each variable on fertility, and certainly exaggerating the role of income distribution.

5.3 The Expanded Approach to the Economic-Fertility Relationship

The work of Gupta (1975, 1982, 1983), in general, is oriented to explain the process of savings and growth.

Demographic variables and income inequality are used by Gupta primarily to provide insight into this process. Given the different subject of this study, we limit the discussion on Gupta's work to the hypothesis of our concern: the effect of income distribution on fertility. Thus, we focus on his 1982 model.[11]

Gupta's (1982) model is less restrictive than the models of Flegg (1979) and Repetto (1979). The model in question includes equations for fertility, life expectancy, the female participation rate, the dependency rate, total labour participation, income per head, the rate of economic growth, savings, and the percentage of labour force in agriculture. In this sense, Gupta's model captures a more realistic measurement of the income distribution multiplier on fertility than the previous models. For instance, it captures the negative link between income and fertility and the direct effect of income distribution on infant mortality (Preston, 1976; Rodgers, 1979). As well, the further endogenization in Gupta's model vis-a-vis the models of Repetto (1979) and Flegg (1979) allows a more robust proof of the income distribution hypothesis. This is so, because the simultaneity bias affecting the explanators of fertility is substantially reduced.

In this model there are two minor aspects which can be discussed. One is the disregard by Gupta of cultural factors which affect, at least, the female participation rate and fertility (Janowitz, 1971; Anker, 1978, Flegg, 1979). The non-consideration of these factors may imply a bias affecting the estimates of the fertility equation, and thus, the coefficient associated with income distribution. Secondly, in the specification of the dependency rate equation, Gupta does not include infant mortality as a direct explanator. Such an omission exaggerates the influence of fertility on the dependency rate and thus on income. Thus, it distorts somewhat the income distribution multiplier on fertility. Finally, contrary to expectation, Gupta finds a negative relationship between income inequality and infant mortality which may bias downwards his multiplier for income inequality on fertility. Other problems in Gupta's work--quality of data and probable multicollinearity--are general problems associated with large models which use a cross-sectional data base.

---

[11] For a brief understanding of Gupta's work from the point of view of savings see the discussion of Adams, Gupta and Leff in the American Economic Review, June 1971. Also see Ram (1982) and Leff (1984).

5.3.1 Problems of Large Models

A central issue in the above kind of research is a trade-off between statistical "purity" and qualitative insight provided by the models. Large models which use a cross-sectional LDCs data base face enormous statistical problems. The variables are often measured with error. These errors, sometimes, are systematically related with the level of development. Thus, besides bias and inconsistency, there is a problem of heteroskedasticity.[12] Multicollinearity is high in cross-section studies and it tends to increase with the size of the model (Anker, 1978). In addition, the TSLS estimates are badly affected by multicollinearity (Intriligator, 1978). These problems make difficult the interpretation of the results of simultaneous equation models. There is a dilemma in rejecting or accepting hypotheses, some which may be essential components of the model. Indeed, it is not clear if the weak significance of some hypotheses is a problem a multicollinearity, unrealibility of the tests, or simply the normal result of the TSLS estimation procedure.

Another problem relates to the level of aggregation when one considers less developed countries as a whole. Several hypotheses are likely to be related with the level of development, and hence, an aggregate treatment of them may imply their statistical insignificance. For instance, Gregory (1976) and Anker (1978) have treated the effect of life expectancy on fertility as positive and negative at lower and higher levels of development, respectively. The aggregate treatment of this effect, thus, is likely to reduce its level of significance (Birdsall, 1977).[13]

---

[12] For instance, it is known that the quality of demographic variables is directly related with the level of development.
[13] See Gupta (1971) for a discussion of the problem of aggregation.

6. THE EMPIRICAL ANALYSIS

The purposes of the empirical analysis are the following. First, to test our main hypothesis of an inverse relationship between income distribution and fertility. Second, to analyze and test the mechanism via which the income-distribution fertility relationship works. That is to say, to examine the direct, indirect, and total effects of income distribution on fertility, as well as the feed-back responses of a decline in fertility on income distribution. Third, to evaluate income distribution as a policy tool with respect to reducing fertility; this objective involves comparing potential negative effects of a better income distribution--as, for instance, a reduction in savings and economic growth--with potential positive effects of a fertility reduction, such as an increase in the labor force and thus an increase in income, or even an increase in the savings rate.

The analysis is organized around the discussion of two fertility models. The first model is a four simultaneous equation system, where fertility, life expectancy, the female participation rate and income distribution are the endogenous variables. This model is a combination of different hypotheses with respect to direct and indirect effects of income distribution on fertility. These hypotheses are associated with Repetto (1979), Flegg (1979), Preston (1976), Rodgers (1979), Gupta (1982) and Kuznets (1976) mainly. The second model, where income distribution is exogenized, has fertility, life expectancy, the female participation rate in the market, the total participation in the labor force, income, savings, the rate of economic growth and the dependency rate as endogenous variables. This model has been adapted from Gupta's (1982) model of demographic pressures on savings. The use of these two systems permits us to meet the general objectives mentioned above and to check the different hypotheses involved in the relationship betwen income distribution and fertility.

This chapter has four sections. The first section deals with general methodological issues. In the second section the four equation model, hereafter called the basic model, is analyzed. Section three deals with several modifications of the basic model in the light of its limitations. Finally, in section four, the eight equation model is analyzed.

6.1 General Considerations

Prior to specifying the simultaneous equation models which were actually estimated, background information is provided with respect to the characteristics of the sample, the particular form chosen to measure the income distribution variable, and the issues involved in the use of simultaneous equations systems.

6.1.1 The Method and the Sample

The method utilized was a cross-section analysis of a sample consisting of 32 less developed countries with observations for 1970. The sample consisted of the following countries : Tanzania, India, Sri Lanka, Bangladesh, Thailand, Philippines, Sierra Leone, South Korea, Honduras, Ecuador, Turkey, Colombia, Malasia, Taiwan, Brazil, Peru, Costa Rica, Mexico, Chile, Panama, Uruguay, Argentina, El Salvador, Venezuela, Kenya, Egypt, Dominican Republic, Spain, South Africa, Indonesia, Pakistan and Iran. Only less developed countries were included in the sample in order to ensure that the conclusions of the study were valid for these kind of nations, and not critically dependent on the inclusion of either developed countries or socialist countries. The latter nations tend to have both higher shares of the bottom 40% households in the national income and lower Gini coefficients, as well as low fertility, and their inclusion can produce apparent good results (Birdsall, 1977).

The number of less developed countries included in the sample, 32, in effect was determined by the need to find LDCs with available data on income distribution around a common year, in this case 1970.

The choice of 1970 as the year of cross-sectional observation was determined by the need to reconcile data availability with an adequate theoretical focus. Actually, the main source of income distribution data is Jain's (1975) compilation which gives an accurate sample close to 1970. More recent data compiled by the World Bank are too few in number to achieve a minimal sample size after 1970.

Given the income distribution data constraint, two alternatives were open in doing the cross country analysis. The first was to measure the observations for the different variables, concerning a given country, for the year where the income distribution data were available. The second was to choose only income distribution data close to a given common year, 1970, and to assume that the income distribution of a country does not change drastically within a maximum period of eight years, and then to measure the rest of the variables for that common year. This latter procedure was the one employed in this study. It has the relative advantage of reducing the likelihood of the results being biased where equations are likely to shift through time - shifts that have been already demonstrated both in fertility and mortality (Birdsall, 1984; Preston, 1976; Rodgers, 1979). However, the chosen procedure depends critically on the assumption that movements in income distribution occur very slowly, an assumption that can potentially prove to be unsatisfactory. However, since most of the income distribution data in our sample is fairly close to 1970, the risk of bias is minimized in comparison with the mentioned alternative procedure.

6.1.2 The Measure of Income Inequality

A substantial portion of the literature on the rôle of inequality deals with the problem of finding some satisfactory measure of income inequality. The most common measure of income distribution, the Gini index, has been criticized on several grounds (Atkinson, 1979; Dahlby, 1985). The most important criticism is that the same Gini index can represent two different patterns of income distribution or, in other words, that two Lorenz curves can generate the same Gini coefficient.

To the extent that the focus of this thesis implicitly considers the role of inequality on fertility as partially working through the inequality-poverty nexus, an index was required to combine a relative inequality measure with some indication of poverty or absolute inequality. Certainly an index which could best meet that requirements, and which was indeed chosen in this study, is the share of the bottom forty percent of households in the national GNP.[14]

In any event, the effect of this index of income distribution on fertility was compared with the corresponding effect of the Gini index. The share of the bottom forty percent, in general, performed better than the Gini in our empirical work.[15]

The choice of the share of the bottom forty percent (SH40) as the income distribution variable has been criticized by Flegg (1979). He notes that, as in the case of the Gini, the share of the bottom forty per cent can also represent two different distributions of income. In addition, Flegg has raised the issue that fertility could be affected differently by the share of the bottom twenty, thirty, or forty percent.[16]

---

[14] Incidentally, Fields (1980) has shown that the Gini coefficient starts to reduce in value before the share of the bottom forty percent starts to rise. This, highlights once more the importance of choosing such a particular share to analyze the relationship between income distribution and fertility.

[15] For instance, using the eight equation model, the size of the coefficient associated with the share of the bottom forty percent in the fertility equation was -1.97 times its standard error, while the size of the coefficient associated with the Gini was 1.08 times its standard error.

With respect to the first criticism, it is less likely that the bottom forty percent (SH40) could represent as easily as the Gini two different income distributions. (This is a probabilistic argument). Most importantly, the share of the bottom forty percent relates to fertility not only because it is an index of relative inequality (which is the point of the criticism) but also because it proxies poverty more clearly than other indexes.[17]

As well, the arguments for choosing the share of the bottom forty percent (SH40) instead of other percents (SH10 or SH20) relate to the more accurate representation of the extent of poverty in LDCs given by SH40. Several studies of poverty and income distribution agree in signaling that the poorest in LDCs, with minor variations, are concentrated in the bottom forty percent of households. As Ahluwalia (1974, p.19) posits "While the percentage breakdown is different for different countries, in all cases the poorest group corresponds to the lowest 40 percent to fifty percent of the population." Birdsall (1980) has documented that the bottom forty percent of LDC households provides the greatest potential for fertility reduction. For instance, in Colombia and Brazil the share in the total number of children of the bottom forty percent of the households is approximately sixty percent. Further, the shares in the total number of children of the bottom two quintiles of households is approximately the same. For instance, in Brazil the afore mentioned share of these two quintiles is 31% and 30%, respectively. Therefore, from a policy point of view, it is more relevant to use the share of the bottom forty percent in the GNP rather than the share of the bottom twenty percent.

---

[16] See Flegg (1979), pp 460, footnote 15.

[17] Recall than in the analysis of the relationship between income distribution and fertility, income is kept constant. Thus a greater or lesser share of the bottom forty percent consecuently indicates lesser or greater poverty in LDCs.

In conclusion, the share of the bottom forty percent (SH40) may be considered as a more "relevant" variable to be taken into account when analyzing the relationship between income distribution and fertility than other percentage shares.[18]

6.1.3 Theoretical Issues in Simultaneous Equation Systems

6.1.3.1 Simultaneity

Simultaneity is defined as a two way causality relationship between the explained variable and the corresponding explanatory variable in a regression model. This means that the error term of the regression is correlated with the explanatory variable; and that, hence, the coefficients estimated by an OLS procedure are biased and inconsistent. This problem is solved by the use of either instrumental variable approaches or two and three stages least square procedures (Koutsoyiannis, 1977).

---

[18] The above statement does not necessarily imply that fertility is less sensitive with respect to the shares of the bottom twenty or thirty percent of households in the GNP rather than with respect to the share of the bottom forty percent. Ultimately, this is a matter of empirical investigation.

Fertility, usually defined as a function of income, education, infant mortality and the female participation rate, certainly involves such dual causality relationships. For instance, income is affected by fertility through variations in the total labor force (Gregory, 1974, 1976; Hazledine, 1977); fertility, secondary education and the female participation rate are simultaneously decided at the household level (Anker, 1978; Willis, 1973); infant mortality can also be affected by fertility (Repetto, 1970).

Therefore, it is clear that the estimation of the fertility function should be done by one of the methods that consider the effects of simultaneity. We chose the two stage least squares method (hereafter TSLS) mainly because of its simplicity. In addition, considering the limitations of cross country analyses, the TSLS method performs comparatively better than other more sophisticated methods because it is less dependent on specification errors (Kmenta, 1971; Johnston, 1984; Koutsoyiannis, 1977).

6.1.3.2 Choice of Functional Form

The choice of functional forms for the different equations in a simultaneous equation system is constrained by the identification condition of the system and the practical interpretation of the results (Judge, et al., 1980). Both constraints imply finally that the same functional form is chosen for all the equations in the model. In choosing a particular functional form, a relevant criterion can be to square theory with applied analysis. In practice, however, it is almost impossible to claim that a common form is superior to another. There will always be cases which a different functional form than the one chosen is better suited for some of the equations, though not all.

In these circumstances, obtaining the multipliers for each of the exogenous variables becomes debatable. Indeed, if the functional form chosen for the system markedly violates the theoretically desirable functional form of one of the equations in the system, then the multipliers for that equation function should considered with great caution.

In deciding the functional form of the two analyzed models, we used likelihood-ratio tests for comparing log-log forms versus linear forms (using the Box-Cox transformation) for each equation of the models.

The results of the log-likelihood ratio tests indicated that the linear functional form was better suited for the equations of fertility, life expectancy, total labour participation rate, dependency rate and income distribution.

On the other hand, the double-log functional form was more appropriate for the savings and income equations. The female participation rate equation can be expressed in either of these forms. However, neither of these forms was appropriate for the rate of economic growth.

The practical and theoretical difficulties involved in estimating a system where the equations have different functional forms led us to choose a common linear functional form for both models. The criterion for choosing the linear functional form was that it resulted in fewer distortions for our central demographic-related equations. Certainly, choosing the linear form did not pose a problem in the first model. In the second model, even though the equations of savings and growth are badly affected by using a linear form, they do not influence the rest of the equations of the system unduly given characteristics of recursivity in such a model. Furthermore, it was convenient to keep the linear form for comparison purposes.

Nevertheless, in order to be certain about the main hypotheses of this research, they were also tested using the double-log form-- that is, re-estimating the system by using all the variables in logs. These tests confirmed, in general, our basic hypotheses.''

'' Specifically, the coefficients associated with income distribution in the structural equations of fertility and life expectancy were more significant for the double-log form than for the linear form.

6.1.3.3 Other Constraints Imposed by Simultaneity

The $\bar{R}^2$ has no meaning in the TSLS results. The T test and F test retain their meaning under the assumption that their distributions are assymptotically normal and Chi-square respectively. The Durbin-Watson test for analyzing autocorrelation also loses its meaning, and the tests for heterocedasticity are very weak in this case (Johnston, 1984).

6.2 The Basic Model

6.2.1 The Rationale for the Model

The basic model is a four equation simultaneous system oriented to test crucial hypotheses involved in the relationship between income distribution and fertility. The model is based on a combination of the models of Flegg (1979) and Repetto (1979), as well as on the hypothesis of a non-linear relationship between income per-head and life expectancy associated with Preston (1976) and Rodgers (1979).

The four equations of the basic model: fertility, life expectancy, the female participation rate and income distribution, capture the essence of the above mentioned models. In Flegg's (1979) model, a more equal income distribution directly decreases fertility, and reduces the female participation rate. The reduction in fertility induces a rise in the female participation rate, which reinforces the initial fertility decline. The reduction in the female participation rate increases fertility. In Repetto's (1979) model, the reduction in fertility, associated with a more equal distribution of income, reduces infant mortality (or increases life expectancy as in our basic model) and improves income distribution. Finally, according to Preston (1976) and Rodgers (1979), a more equal income distribution directly improves life expectancy--when income is kept constant.

The combination of these different models, thus, requires the use of the four equations initially mentioned. This combination also allows a more complete specification of the relationship between income distribution and fertility than that provided by those models in isolation. In addition, it allows the testing of the main hypotheses related to direct and indirect effects of income distribution on fertility.[20]

The relationships between income distribution and fertility, depicted by the basic model, can be explained in simple mathematical terms, as follows:

Fertility (CBR) is esentially specified as a a negative function of life expectancy (LEB), the female participation rate (FPL), the share of the bottom forty percent of households in GNP (SH40)--as the measure of income distribution, and other exogenous variables herein represented by X. In linear form we have that:

---

[20] The detailed specification of each of the equations of the basic model differs from the analogous equations used by Flegg (1979) and Repetto(1979), in an attempt to provide a better specification.

$$(1)\ CBR = a_0 + a_1LEB + a_2FPL + a_3SH40 + a_4X$$

Life expectancy (LEB) is specified as a positive function of income distribution (SH40), and as a negative function of fertility (CBR). That is:

$$(2)\ LEB = b_0 + b_1SH40 + b_2CBR$$

The female participation rate is specified as a negative function of fertility (CBR) and income distribution (SH40):

$$(3)\ FPL = c_0 + c_1SH40 + c_2CBR$$

Substituting (2) and (3) into (1), the total effect of income distribution on fertility can be expressed as:

$$\frac{a_3 + a_1b_1 + a_2c_1}{1 - a_1b_2 - a_2c_2}$$

where only a_2c_1 in the numerator is positive and both a_1b_2 and a_2c_2 in the denominator are positive and their sum is less than one.

Therefore, the negative direct effect of income distribution on fertility may be increased due to the positive direct effect of income distribution on life expectancy and by the negative direct effects of fertility on life expectancy and income distribution, respectively. On the other hand, the total effect of income distribution on the female participation rate offsets at least partially the total effect of income distribution on fertility.

However, the existence of the above components of the income distribution multiplier on fertility is hypothetical. Therefore, the tests for such components will clarify the importance of the total effect of income distribution on fertility. For instance, if there is no direct effect of income distribution on the rate of female participation and thus $c_1 = 0$, the above multiplier increases. If there is no negative direct effect of fertility on life expectancy , and thus $b_2 = 0$, such a multiplier decreases.

In the basic model, however, income distribution is also endogenous. SH40 is defined, esentially, as a negative function of fertility (CBR). That is:

(4) $SH40 = d_0 + d_1 CBR$

Therefore, the importance of income distribution in affecting fertility becomes implicit in the model. Certainly, the negative effect of fertility on income distribution reinforces the effect of the latter on fertility. However, formally both variables are now endogenous to the system, and thus, the total effect of income distribution on fertility can only be suggested. In addition, the negative effect of fertility on income distribution implies that the multiplier of the exogenous set of variables X, is reinforced to the extent that d_1 is different than zero.

Finally, it must be insisted that the basic model is oriented to test the direct effects involved in the relationship between income distribution and fertility rather than being used readily for policy analysis. Indeed, given the endogeneity of income distribution, the approach to a policy or multiplier analysis can only be indirect.

6.2.2 The Model Specification

The detailed specification of the four linear equations is as follows:

Fertility

(1) $CBR = a_1 + a_2YPH + a_3SH40 + a_4ADI + a_5SR + a_6FPL + a_7LEB + a_8X_4 + e_1$

Life expectancy at birth

(2) $LEB = b_1 + b_2YPH + b_3SH40 + b_4ADI + b_5CBR + b_6DT + e_2$

Income distribution

(3) $SH40 = c_1 + c_2YPH + c_3CBR + c_4ASH + c_5ADI + c_6RG + c_7E_1 + c_8E_2 + e_3$

Female participation rate

(4) $FPL = d_1 + d_2YPH + d_3CBR + d_4X + d_5 X_7 + d_6SH40 + e_4$

Endogenous Variables

CBR = crude birth rate

LEB = life expectancy at birth

SH40 = share of the bottom 40% of the households in GNP

FPL = female participation rate

Exogenous Variables

YPH = income per-head in U.S. dollars, 1970

ADI = illiteracy rate of the adult population

SR = secondary school enrolment ratio

RG = rate of growth of GDP, calculated as the average annual rate in the 1965-73 period

ASH = share of the agricultural sector in the national product

E_1 = dummy variable representing deliberate efforts of the government to achieve equality: 1 if the country makes this effort, 0 elsewhere

E_2 = dummy variable representing a pattern of development biased to inequality : 1 if the pattern is present 0 if not

X = dummy variable for Muslim cultural influence: value 1 for predominant Muslim countries, 0 elsewhere

X_7 = dummy variable reflecting the degree of structural change: 1 if a country had either at least 50% of its labour force in agriculture, or at least 50% of its GDP came from the agricultural sector, 0 elsewhere

X_4 = dummy denoting African cultural influence: value 1 for any African nation and 0 elsewhere

DT = percentage of requirements met by per capita calorie supply

6.2.2.1 The Fertility Equation

The fertility equation has been interpreted herein both as an approximation to the static demand for children (Gregory, 1976; Birdsall, 1977, Williams, 1976; Schultz, 1981) and as a macro relation between fertility and several indexes of development (Adelman, 1966; Krishnamurty, 1966; Heer, 1966; Janowitz, 1977). It must be noted, however, that these two interpretations can not be separated in cross-country analyses.

The crude birth rate, CBR, was chosen as the best available measure of fertility. In fact, the data of better measures of fertility are very scarce for LDCs. It is known that the CBR is influenced by the age structure of the society and hence the estimated coefficients of the explanatory variables can be biased, if these explanators are in turn correlated with such an age structure (Anker, 1978; Adelman, 1966; Birdsall, 1977). However, this possible bias is not that serious. In fact, an alternative measure of fertility which is free from the influence of age structure, such as the Gross Reproduction Rate, is usually highly correlated with the CBR -- with a correlation about 0.9 (United Nations, 1981).

Income per head, YPH, is a neccesary element of control in the fertility equation. Our contention is that YPH can be thought of as a proxy for exogenous and endogenous household-income.[21] From this consideration it is seen that there must be income and substitution effects associated with a variation in YPH, and its sign should reflect which of these effects predominates (Gregory, 1976; Willis, 1973). Nevertheless, there are other plausible interpretations as well. In fact, other analyses interpret the role of income as a "pure income effect", when the female participation rate is controlled. Thus, one would expect a positive sign associated with the income coefficient (Birdsall, 1976; Williams, 1976). Finally, Flegg (1979) has contended that children should be considered inferior goods in LDCs. Given all these plausible arguments, the effect of income on fertility can not be signed.[22]

---

[21] Income per head, in part, is a proxy for the wage rate, and hence, for the value of time, and thus, the price of

The reasons for including income distribution , proxied by the "share of the bottom forty per cent of households in national income" (SH40), in the fertility equation were discussed in Chapter 2. Nevertheless, we briefly mention here three of those arguments. First, given that the subject of analysis is the aggregate demand for children, income distribution must be incorporated into the function-- unless household tastes are homothetic and the Engel curve for children is linear. Second, increases in endogenous household-income tend to be dominated by the income effect

---

[21](cont'd) children. Therefore, a rise in income, hours of labour constant, has associated income and substitution effects on the consumption of children.

[22] Simon (1969, 1974) has shown that the sign of the income effect in cross-country studies should be negative, in spite of what theoretically the pure income effect could be. The reason for this is that countries of higher income level have associated a higher relative price of children, which can not be totally isolated in the fertility equation.

in high-income households and by the substitution effect in low-income households. Third, beyond some level of development, children may be considered inferior goods by poor people and normal goods by rich people (refer to Chapter 3).

The postulated sign for SH40 is negative given our hypothesis of an inverse relationship between income distribution and aggregate fertility.

Two educational variables were incorporated in the function: the adult illiteracy rate, ADI, and the secondary enrolment ratio, SR. The linear correlation between ADI and SR, equal to -0.67, was not strong enough to impede the joint estimation of both parameters.

ADI performs several roles. First, given that the wage rate is a positive function of education, ADI proxies a net result of income and substitution effects of the parents' wage rate.[23] Second, it also proxies both contraceptive efficiency and mortality prevention (Birdsall, 1977; Schultz, 1981). Thirdly, it proxies attitudes and tastes towards children consumption (Freedman, 1976; Birdsall, 1977). Fourth, it proxies knowledge about the market, and "information" required to substitute quantity for quality. Finally, ADI is directly related with the strength of the pension motive (Mueller, 1976; Repetto, 1976). In summary, we should expect a positive relation between the illiteracy rate of parents and fertility (or a negative relationship between education and fertility).

---

[23] ADI is related to the price of children, through the effect of education on the value of time of the parents. See Willis (1971), Ben-Porath (1971) and Gregory (1976).

The secondary enrolment ratio (SR) was included since it represents a net cost of children. That is, the higher the SR, the more is the foregone income that the child would have produced, and the more the resources parents will have to spend on children. SR also reflects a trade-off decision at the household level, between quantity and quality of children (Anker, 1978). Hence, a negative sign for the coefficient associated with SR should be expected.[14]

The inclusion of the FPL variable in the fertility equation was fully discussed in Chapters 3 and 4. In brief, its role in the equation is to measure the oportunity cost of children, and the sign of the corresponding coefficient to be expected is negative (Williams, 1976).

The life expectancy variable, (LEB), was included instead of infant mortality in order to capture, in a more general sense, the mortality-fertility relationship. LEB reflects the higher value of life which occurs when mortality declines. From this perspective not only a "replacement mechanism" is captured by the inclusion of this variable in the equation, but also a substitution out of quantity and into quality, enhanced by the higher value of life (Schultz, 1976). The expected sign was again negative. However, herein there was more room for ambiguity given that first, the demand for children should not necessarily be considered as price inelastic in an LDC framework, as it is implied by the replacement mechanism; and second, higher life expectancy can have unperceived effects on higher fecundity, thus affecting fertility positively (Schultz, 1981; Lindert, 1980; Easterlin, 1976). Nevertheless, such impacts are apt to occur in the first stages of development, and having a sample consisting of low, medium and high income less developed countries, the most probable outcome was the predominance of a negative sign with respect to life expectancy.

---

[14] Primary education could be considered more important than SR in the afore context. However, its correlation with ADI was too high: -0.78, in order to have used it instead of SR.

X_4, the dummy variable representing African cultural influence (with value 1 when the country is African and 0 elsewhere), was included to take into account extreme diverse cultural patterns affecting the demand for children, or their production. Other dummies representing Asian, Latin America, and Muslim influence were attempted. None of these performed well, except X_4, which was surprising, given the fact that fertility rates in Africa tend to be the highest in the world, and the sign for X_4 was negative (Janowitz, 1971; Anker, 1978).

6.2.2.2 The Life Expectancy Equation

Life expectancy was treated as dependent on income per head (YPH), income distribution (SH40), the adult illiteracy rate (ADI), fertility (CBR), and the percentage of requirements met by per capita calorie supply (DT).

The hypotheses related to these variables follow. YPH should affect life expectancy positively because of its obvious connection with standard of living and thus with either basic health conditions or access to the services of medical care. The inclusion of the income distribution variable (SH40) was justified because of our interpretation of life expectancy as being non-linearly related with income (Preston, 1976; Rodgers, 1979); its expected sign was positive since SH40 is inversely related to income inequality.

Fertility, CBR, was included since it could affect life expectancy inversely in the following ways. Firstly, high fertility would imply that an important percentage of children are born from too old or too young mothers, increasing the risk of child death. Secondly, high fertility implies closely spaced births, therefore a deterioration in the mother's health condition, and thus in the child's health. Thirdly, this latter outcome will be reinforced by the lack of child care which is related to high children quantity per family (Russell, 1974; United Nations, 1970; Repetto, 1979). Nevertheless, a high degree of caution must be placed on the interpretation of the effect of this variable. In fact, its effect on life expectancy can reflect only an spurious relationship given that a mortality reduction always accompanies development and, of course, accompanies fertility decline. Therefore, even a significant effect of CBR on LEB can not be interpreted necessarily as causality.[25]

The percentage of requirements met by per capita calorie supply (DT) was included in order to measure the impact of nourishment conditions on life expectancy. Its expected sign was positive.

Education, this time proxied only by ADI, the adult illiteracy rate, was expected to affect life expectancy inversely, as was discussed fully in previous chapters.

Urbanization (UR)--the share of the urban population in the total population--was initially considered as a potential explanatory variable in the life expectancy equation. Its exclusion in the equation was due to the high correlation with YPH (0.83). In addition, from a developmental point of view, its effect on life expectancy can not be distinguished from that of income.

6.2.2.3 The Income Distribution Equation

Per-capita income, YPH, was included as an explanatory variable in the income distribution equation for the following reasons. Firstly, higher per-capita income is related positively to urbanization and industrialization. Therefore, on the one hand, a higher per-capita income is associated with an increase in the demand for skilled labor. On the other hand, it is associated with a reduction in the demand for unskilled people, women, and children. From this perspective, the net effect of YPH on SH40 is ambiguous. In general, it is hypothesized to worsen the income distribution in the short-run but to improve it in the long-run. Secondly, a higher per-capita income is usually related to higher capital per-head, implying the possibility of a higher capital share in the product and therefore higher inequality; third, in general income per-head is positively related to government intervention in redistributive matters (Ahluwalia and Chenery, 1981; Repetto, 1979; Fields, 1972). However, a cross-country analysis replicates a long-run situation; thus, on this basis, the expected sign of YPH should be positive.

---

[25] See Oey (1981), for a discussion related to the circularities involved in fertility studies.

The rate of growth of the economy, RG, might capture the short-term relationship between income and income distribution. In fact, it is plausible that a faster rate of economic growth could be accompanied by increasing inequality. This hypothesis, however is not certain. Indeed, Adelman and Morris (1971) and Chenery and Ahluwalia (1974) have shown that this relationship is positive.

The crude birth rate affects the income distribution negatively in LDCs. The basis for this effect lies in the fact that aggregate fertility in these countries is largely determined by the fertility of the poor, which is substantially higher than that of the rich (Birdsall, 1980; World Bank, 1984; Kuznets, 1976, 1980). The fact that the poor have higher fertility than the rich implies that the wealth endowment of the poor and that of the rich must widen as time goes on. The high fertility of the poor implies a lower human capital formation than for the rich: malnourishment, poorer education, and so on. To the extent that human capital formation determines future income, it is clear that high aggregate fertility is related with a deterioration of income distribution (Cassen, 1976; Singh, 1972; Myrdal, 1972).

ASH, the share of the agricultural sector in the GNP, was incorporated as a measure of structural factors related to income distribution (Adelman and Morris, 1971). Its expected sign was to be positive.

E_1 and E_2 are dummy variables which capture the attitudes of governments with respect to the achievement of equality. The rationale for their inclusion comes from the known fact that inequality in LDCs is importantly explained by the political biases of these societies and their class structures (Todaro, 1985; Adelman and Morris, 1971; Ahluwalia, 1981). Therefore, an effort was made to classify countries in three categories. There are several countries which have a clear policy bias to equality: for instance, Sri Lanka, Taiwan, and South Korea.[26] On the other hand, there are countries which have displayed clear patterns of dualistic economic development, also fully reported, such as Mexico, Brazil, and South Africa. [27] Nevertheless, most of the countries were classifed in a category wherein the government attitude to the promotion of equality was regarded to be neutral.

---

[26] This bias has been fully reported by several sources: World Bank Reports (1982, 1984), Kocher (1973), Rich (1973).

[27] In South Africa the apartheid institution has had a definitive impact in maintaining inequality.

6.2.2.4 The Female Participation Rate Equation

Income per-head, YPH, should affect the female participation rate negatively. Indeed, if we control for structural factors (X7) which is related positively to the supply of jobs for females, for the crude birth rate (CBR), and for Muslim cultural influences (X), YPH can be considered as a proxy for household-income. An increase in exogenous household income--for instance, non-earned income, or income of the husband--should raise the value of time of the female at home thus discouraging work in the market (Willis, 1973; Gronau 1977). Secondly, if a rise in YPH represents a higher wage rate in the market (endogenous household-income), the aggregate FPL will be reduced. This is so because our initial contention (Chapter 2) was that poor women in LDCs are likely to consider leisure as a luxury, whereas the minority of rich women consider leisure as an inferior or basic good. Therefore, the sign of the YPH coefficient should be negative for LDCs. Notice that in a sample of developed countries the sign of YPH could be the opposite (Schultz, 1981).

Income distribution, SH40, is postulated to affect the FPL negatively, for similar reasons as those justifying the effect of SH40 on fertility--that is the non-linear relationship between FPL and YPH (refer to Chapter 2).

The crude birth rate, CBR, is postulated to affect the female participation rate negatively. First, it is likely that a greater number of children, everything else constant, raises the value of the mother's time in home activities (Willis, 1973). More simply, it is possible that a greater number of children becomes incompatible with work in the labor market (Gupta, 1982).

X, the dummy for Muslim influence, reflects the fact that Muslim predominant cultures discourage women from working outside the home (Dixson, 1976; Flegg, 1979; Kirk, 1966).

X_7 shows the structural effect of being predominantly an agricultural economy, which should be positively related with the female participation rate, given the assumption of greater compatability between agricultural work and child rearing, and the higher demand for women's work in that stage of development (Kasarda, 1971; Jaffe, 1960; Boserup, 1965).

Finally, the educational variables were attempted as explanators of the FPL, but were dismissed due to their lack of statistical significance.

6.2.3 The Results

The system was estimated using both OLS and TSLS procedures. The OLS estimates are biased since this method does not take into account the simultaneity embedded in the system. They do, however, provide a primary orientation of the structure of the system. In addition, it is important to compare the OLS estimates with the TSLS estimates in order to assess the strength of the bias and to know which coefficients are most affected by bias.

The OLS estimates of the system--structural coefficients--are reported in Table 6-1 and the TSLS estimates in Table 6-2.

6.2.3.1 OLS Results

Let us analyze the fertility equation first. The coefficient associated with per-capita income (YPH) is statistically significant; its sign was negative.[28] The coefficient for income distribution (SH40) is positive as expected, and statistically significant at the 1% level in a two tail test. The adult illiteracy rate has an unexpected negative sign but the coefficient is not statistically significant. Life expectancy (LEB) and the female participation rate (FPL) both have the correct sign and are statistically significant at the 10% level in a two-tail test. Finally, X_4, the dummy variable representing African cultural influences, is strongly significant and affects fertility negatively.

In the life expectancy equation, it is worth noting that the signs of all the variables: YPH, SH40, ADI, CBR and DT, are as expected. However, the estimated coefficients of YPH, DT, and CBR are not statistically significant.

---

[28] The negative sign associated with the income variable in the fertility equation is a common result in research related to samples dominated by LDCS; while the presence of a positive sign related to the effect of income on fertility is more commonly found in research about developed countries. Refer to Birdsall (1977).

Table 6-1

Ordinary Least Squares Estimates of the Four Equation Simultaneous System--The Basic Model

	Fertility			Life Expectancy			Income Distribution			Female Participation Rate	
	CBR			LEB			SH40			FPL	
Var.	Coeff.	t-value	Var.	Coeff.	t-value	Var.	Coeff.	t-value	Var.	Coeff.	t-value
Constant	90.95	4.0*	Constant	56	5.23*	Constant	0.061	0.9	Constant	0.30	2.6*
YPH	- 0.0062	-1.4**	YPH	0.002	0.89	YPH	0.000057	1.29	YPH	-0.000070	-1.32**
SH40	-59.37	-2.8*	SH40	25.17	1.56**	CBR	-0.0016	-1.7*	CBR	-0.0012	-0.65
ADI	- 2.34	-0.24	ADI	-25.61	-7.06*	RG	0.0064	2.38*	X_1	-0.16	-4.38*
SR	-22.56	-2.1*	CBR	-0.042	-0.38	ASH	0.273	2.84*	X_2	0.075	2.61
LEB	- 0.51	-1.47**	DT	0.078	0.91	E_1	0.034	1.54**	SH40	0.17	0.55
FPL	-18.09	-1.59**				E_2	-0.027	-1.97*			
X_4	-9.76	-3.04*									
	R^2=0.75			R^2=0.85			R^2=0.62			R^2=0.61	

* Significant at 5% or less - 2 tail test.

** Significant at 10% level - 1 tail test.

Sample size = 32.

In the income distribution equation, all the coefficients have the expected signs, and most of them are significant. In fact, the rate of economic growth (RG) and the share of agriculture in the GNP (ASH) are significant at the 5% level (two-tail test); per capita income, the crude birth rate, and the dummy variables E1 and E2 are significant at a 10% level (one-tail test).

Finally, in the female participation rate equation, the signs of all the relevant variables were as expected except for that on income distribution. In fact, income distribution affects the FPL positively contrary to what was postulated. The coefficients of X_7 and X, the dummies for structural stage of development and the muslim cultural influence respectively, are significant at the 5% level in a two-tail test. The coefficient for the crude birth rate and that for income distribution, on the other hand, are not significant.

6.2.3.2 TSLS Results

It is worth noting the following changes in the estimates when the TSLS estimation procedure was used.

In the fertility equation, the size of the coefficient of income distribution is reduced, while the coefficient of the female participation rate is significantly increased. To be more specific, these changes involve a decline in the elasticity of fertility with respect to income distribution from 0.19 as estimated by OLS to 0.15 as estimated by TSLS. On the other hand, the elasticity of fertility with respect

Table 6-2

Two Stage Least Squares Estimates of the Four Equation Simultaneous System--The Basic Model

	Fertility			Life Expectancy			Income Distribution			Female Participation Rate	
	CBR			LEB			SH40			FPL	
Variable	Coeff.	t-value	Variable	Coeff.	t-value	Variable	Coeff.	t-value	Variable	Coeff.	t-value
Constant	114.6515	2.43*	Constant	53.37	3.96*	Constant	0.036	0.43	Constant	0.39	2.45
YPH	- 0.0059	-1.17	YPH	0.0046	1.32**	YPH	0.000067	1.39**	YPH	-0.000094	-1.54**
SH40	-47.37	-1.41**	SH40	49.51	2.36*	CBR	-0.0011	-0.79	CBR	-0.0028	-1.066
ADI	- 11.37	-0.63	CBR	0.028	0.18	ASH	0.27	2.86*	X	-0.15	-3.66*
SR	-19.1	-1.38**	ADI	-25.9	-6.66*	RG	0.0062	2.26**	X,	0.077	2.64*
FPL	-26.85	-1.84**	DT	0.054	0.587	E,	0.04	1.6**	SH40	0.0022	0.0053
LEB	-0.87	-1.13				E,	-0.028	-2.02*			
X.	-10.57	-2.57*									
	R^2=0.73			R^2=0.84			R^2=0.61			R^2=0.60	

* Significant at 5% or less -2 tail test.

** Significant at 10% level -1 tail test.

Sample size = 32.

to the female participation rate increases from 0.11 to 0.17. In summary, SH40 remains significant only at the 10% level (one tail test), while the significance of FPL rises. With respect to the other variables in the equation , we note that LEB is no longer significant, X_4 is not affected, and ADI still remains non-significant and with the wrong sign.

The remaining important changes are analysed by following the trajectories of the elements that link the effects of income distribution on fertility and vice versa.

In the life expectancy equation, the income-distribution elasticity of life expectancy rises from 0.056 as estimated by OLS to 0.11 as estimated by TSLS. In fact, income distribution becomes the second most important explanator of life expectancy after parents' education, ADI. It is worth noting that the ADI coefficient is about 7 times its standard error, while that of SH40 is about 2 times. The crude birth rate (CBR) coefficient changes from negative as estimated by OLS to positive as estimed by TSLS, which certainly is an undesired change. The coefficient, however, remains insignificant.

In the female participation rate equation, the coefficient associated with the crude birth rate rises relative to its standard error. It does not, however, become significant, and its sign remains the same. The coefficient of income distribution remains positive and statistically insignificant. The rest of the coefficients are not altered either in terms of signs or in terms of statistical significance.

Finally, in the income distribution equation, the CBR coefficient is no longer significant. The rest of the coefficients are not altered.

6.2.3.3 The Mechanism of the Inequality-Fertility Relationship

Since our model endogenizes the income-distribution variable, we can only suggest an approximation of the total effect of income inequality on fertility. This is done by examining the relevant average direct elasticities obtained from the TSLS estimation--Table 6-5.[29]

An improvement in income distribution (SH40) by 10% directly reduces fertility by 1.5 percent, and raises life expectancy by 1.1 percent. In turn, the improvement in life expectancy further decreases fertility by 1.43 percent. This induced reduction in fertility feeds back in a 1 percent improvement in income distribution. This latter improvement has only marginal and negligible effects in reducing fertility further.

In the analysis we have not considered the positive effects of the crude birth rate on life expectancy, nor of income distribution on the female participation rate. Actually, both effects are of a negligible magnitude and do not alter the results mentioned above. The analysis suggests that the total average elasticity of fertility with respect to income distribution is about 0.28. Indeed, this value is very close to those reported by Flegg (1979) and Gupta (1982).

---

[29] Another possible method to approximate the total effect of an endogenous variable on another endogenous is to use intercept multipliers. See Gregory (1972). In fact, they were attemped here but they gave unrealistic estimates.

6.2.3.4 The Analysis of the Reduced Form

Given that this model endogenizes three important determinants of fertility--LEB, SH40, and FPL, the analysis of the reduced form is not that important. In other words, this system is oriented towards estimation and testing of structural coefficients rather than towards policy analysis. Specifically, it was considered important to test the income distribution hypothesis, with SH40 as an endogenous variable in the system. Nevertheless, the analysis of the reduced form still should be useful in analyzing the total effects on fertility of some important exogenous variables such as YPH, ADI, SR, and DT.

This latter analysis, however, is impaired by the presence of three wrong signs in the system: the negative sign of ADI, the positive sign of CBR and the positive sign of SH40 in the structural equations of fertility, life expectancy and female participation rate, respectively. In fact, the indirect estimation of total effects, by deriving them from the TSLS estimates of the structural coefficients, will be distorted because of the above mentioned wrong signs. In this simple model, however, the distortion can be somewhat controlled. In fact, the wrong sign of ADI

Table 6-3

OLS estimates of the Reduced Form Equations--The Basic Model

Endogenous Variables	Exogenous Variables											
	YPH	ADI	SR	DT	X	X7	RG	ASH	E1	E2	X4	R^2
CER	-0.0071	10.9	-34	-0.16	0.26	-2.25	0.13	-16.89	-3.03	3.23	-8.09	0.75
	(-0.9)	(1.13)	(-3.02)*	(-1.11)	(0.06)	(-0.5)	(0.29)	(-0.83)	(-0.67)	(1.27)	(-2.25)*	
LEB	0.0018	-15.5	9.28	0.127	-0.0083	-2.86	-0.18	0.99	2.56	-1.28	-5.07	0.93
	(0.47)	(-3.19)*	(1.60)**	(1.62)**	(-0.003)	(-1.27)	(-0.79)	(0.09)	(1.13)	(-1.00)	(-2.81)*	
SH40	0.0006	-0.031	0.023	0.0014	0.043	-0.017	0.00607	0.34	0.028	-0.028	0.01	0.71
	(1.28)	(-0.56)	(0.35)	(1.59)**	(-1.64)**	(-0.66)	(2.26)*	(2.92)*	(1.09)	(-1.91)	0.5	
FPL	-0.0002	-0.12	0.166	0.0003	-0.16	0.083	0.0085	-0.0085	-0.1	-0.078	0.062	0.79
	(-2.14)*	(-1.34)**	(1.52)**	(0.21)	(-3.8)*	(1.96)*	(1.95)*	(-0.32)	(-2.46)*	(-3.25)*	(1.82)*	

* Significant at 5% level or less.

** Significant at 10% level.

Sample Size = 32.

Values in parentheses are t ratios.

Table 6-4

TSLS Estimates of the Reduced Form Equations--The Basic Model

Endogenous	Exogenous Variables										
Variables	YPH	ADI	SR	DT	X	X_1	RG	ASH	E_1	E_2	X_8
CBR	-0.0115	13.1	-22.4	-0.055	4.74	-2.43	-0.66	-28.75	-4.26	2.98	-12.44
LEB	0.004	-26.24	0.59	0.055	-0.12	0.064	0.32	14.12	2.09	-1.46	0.32
SH40	0.00007	-0.014	0.024	0.00006	-0.0052	0.0026	0.0069	0.3	0.044	-0.031	0.013
FPL	-0.00006	-0.036	0.062	0.00015	-0.16	0.08	0.0018	0.081	0.012	-0.008	0.034

Numbers are the estimated coefficients of the reduced form.

The reduced form coefficients are obtained indirectly by using the TSLS estimates of the structural coefficients.

Table 6-5

Direct and Total Elasticities in the Basic Model

(TSLS Based)

	Fertility CBR		Life Expectancy LEB		Income Distribution SH40		Female Participation Rate FPL	
	Direct Elasticity	Total Elasticity	Direct Elasticity	Total Elasticity	Direct Elasticity	Total Elasticity	Direct Elasticity	Total Elasticity
CBR	-	-	0.019	-	-0.33	-	-0.44	
LEB	-1.3							
FPL	-0.17**							
SH40	-0.15**	-	0.11*				0.0011	
YPH	-0.064	-0.12	0.033**	0.029	0.21**	0.26	-0.15**	-0.1
ADI	-0.11	0.13	-0.17*	-0.17	-	-0.042		-0.05
SR	-0.13**	-0.16	-	0.0028	-	0.054		0.06
DT	-	-0.15	0.09	0.09	-	0.04	-	0.06
RG	-	-0.09	-	0.03	0.28*	0.31		0.14

The numbers are average elasticities.

* means that the associated coefficient is statistically significant at a 5% level - 1 tail test.

** means that the associated coefficient is statistically significant at a 10% level - two tail test.

underestimates the total effect of this variable on fertility, without distorting necessarily the estimates of the total effects of the other exogenous variables on fertility. The other two unexpected signs have minor distortionary effects.

The OLS and TSLS estimates of the reduced form coefficients are reported respectively in Tables 6-3 and 6-4. The TSLS estimates of direct and total average elasticities are reported in Table 6-5. In the following, we concentrate on the analysis of the reduced form equation of fertility exclusively.

The total elasticity of fertility with respect to income per-head is -0.12 while the corresponding direct elasticity is -0.064. Given the low direct elasticity of life expectancy with respect to income per-head (0.033) and the important negative direct elasticity of the female participation rate with respect to income per-head (-0.15), it follows that the difference between the direct and total effects of income per-head on fertility is explained basically by the important positive effect of income per-head on income distribution (corresponding elasticity equal to 0.21), and the induced improvement in income distribution caused by the fertility decline.

The total elasticity of fertility with respect to the adult illiteracy rate, ADI, is 0.13. The corresponding direct elasticity is -0.11. The correct sign associated with the total elasticity reflects the powerful negative effect of ADI on life expectancy which ultimately raises fertility. Such an effect counteracts the distorted negative effect of ADI on fertility. Certainly, the ADI multiplier is downwards biased which impairs a comparison with the total effect of income distribution on fertility.[30]

The total elasticity of fertility with respect to secondary education equals -0.16 while the direct elasticity is -0.13. This close difference between both effects reflects the fact that SR has no other direct effects on the system.

Finally, the total elasticity of fertility with respect to DT, calorie intake as a percentage of minimal requirements, equals -0.15. This elasticity is explained by the positive direct effect of DT on life expectancy which ultimately reduces fertility.

These results suggest that the total effect of income distribution would be the most important, except for adult education, whose multiplier is not certain as explained above, and it is likely to be as important as that of income distribution. In addition, it must be recalled that the wrong signs of income distribution on the female participation rate equation (positive) and that of the crude birth rate on life expectancy underestimate somewhat the afore analyzed multipliers. [31]

---

[30] If the direct effect is negative when it should be positive and the indirect effect is positive, it follows that the total effect is downwards biased (Koutsoyiannis, 1977).

[31] This was checked by analyzing the reduced form equation of fertility. The negative product of the coefficient

Finally, it is worth noting that, in general, the TSLS estimates of the reduced form coefficients of fertility are fairly close to the respective OLS estimates.

6.2.4 Limitations of the Basic Model

The basic model entails certain problematic results which raise doubts about the robustness of our hypotheses with respect to the effects of income distribution on fertility. In addition, as was shown before, they impair the usefulness of the model for policy analysis.

These problematic results can be summarized as follows. First, the structural coefficients of the fertility equation are noticeable by their small size relative to their standard errors. In particular, the SH40 coefficient is only 1.4 times its standard error, which means that the associated hypothesis of a negative direct effect of SH40 on fertility is accepted only at the relatively weak, 10% level in a one tail test. Second, there are three unexpected signs in the system: the negative sign of ADI in the structural equation of fertility; the positive sign of the CBR coefficient in the structural equation of life expectancy; and finally, the positive sign of SH40 in the female participation rate structural equation. Third, some of the

---

[31] (cont'd) associated with CBR in the equation for SH40 times the coefficient associated with LEB in the fertility equation outweighs the positive product of the structural coefficients of LEB, SH40, and CBR in the equations for CBR, FPL and SH40, respectively. The consequent result is an slight over-estimation in the denominator of the multipliers.

key hypotheses required to lead to the result that the total effect of income distribution on fertility is greater than its direct effect are apparently rejected by the model. That is, the effect of life expectancy on fertility , of fertility on the female participation rate, and of fertility on income distribution are not statistically significant.

In evaluating these results, however, we must take into account the following considerations. The first is to assess what should be the criterion for accepting or rejecting hypotheses given the limitations of a cross-section analysis of LDCs. The second is to analyze the effect, on the estimates, of a high degree of multicollinearity in the system--particularly in the fertility equation. The third is to consider that this model has an exploratory character with respect to two hypotheses: namely, the effect of SH40 on the FPL and the effect of CBR on LEB. Finally, we cannot rule out a probable misspecification of one of the equations.

6.2.4.1 The Criterion for the Acceptance of Hypotheses

With respect to the first issue, we consider that the minimal standard for accepting an hypothesis should be the 10% level of significance (one tail test) provided that the sign of the tested coefficient (Student's t distribution) is the correct one. The reason for choosing this criterion was mainly the strong limitations of cross sectional analysis. In addition, we did not condition the analysis of total effects--multipliers--to the statistical significance of all the involved coefficients; the prerequisite for this kind of analysis was that the involved coefficients should have the correct sign.

In the particular case of the significance of the direct effect of SH40 on fertility, there are other arguments to suggest that this effect is, indeed, important. One of these arguments is to judge the t-ratio associated with the SH40 variable, relative to the t-ratios associated with the rest of the explanators in the equation (Table 6-2). This comparison favours SH40. Furthermore, as we will examine later, the significance of SH40 seems to be dependent on the system specification. That is, when SH40 is considered exogenous to the system, its significance is drastically enhanced.

6.2.4.2 The Multicollinearity Problem

Multicollinearity affects strongly the structural coefficients of the fertility equation, and particularly those associated with ADI and LEB. The general effect of this high degree of multicollinearity is the small size of the coefficients relative to their standard errors. A particular effect is the non-significance of ADI and LEB, and the wrong sign of ADI. [32]

In fact, an inspection of the matrix of linear correlation of the variables used in the system--Table 6-6--shows that the correlation between ADI and LEB: 0.89, is indeed the highest of all the pairs in the survey. In Table 6-7 we report the collinearity present in the TSLS estimation of the fertility equation. The table shows the multiple correlation coefficients of successive regressions run among the explanatory variables of fertility --choosing each of them in turn as the dependent variable and using the remainder as the explanatory variables.[33] The inspection of these results shows that the R^2 associated with the regression of the explanators on LEB is 0.99, and that of the regression of the explanators on ADI is 0.95. are This confirms that the problem of multicollinearity affects mainly these two variables. In addition, the stability of the signs of the coefficients in the structural equation of fertility with respect to small changes in the size of the sample was checked. All the signs were stable with the exception of ADI, whose sign in two cases was positive.

---

[32] In the limit, extreme high collinearity can result in the reversal of the sign of the involved coefficient, as is the case with ADI (Koutsoyiannis, 1977; Kmenta, 1971).

In summary, both the wrong sign of ADI and the statistical insignificance of LEB and ADI are a result of the high collinearity pattern present in the fertility equation. This does not imply either that we should eliminate ADI or LEB from the fertility equation nor that the model is misspecified. [34] It simply implies that we cannot accurately know the effect of ADI on fertility.

---

[33] This is an adaptation of the Farrar and Glauber method to the TSLS case. See Johnston (1972, p. 173; 1984, p. 247).

[34] The elimination of a variable from an equation based on its weak significance is inappropriate if such a weak significance is caused by multicollinearity. In this case, the elimination of the affected variable produces a bias in the estimated coefficients of the remaining variables (Kmenta, 1971, p. 389).

Table 6-6

Linear Correlation Matrix of Principal Variables Used in the Basic Model

	CBR	YPH	SH4O	ADI	SR	FPL	LEB	UR	DT
CBR	1	-0.54	-0.36	0.57	-0.71	-0.05	-0.63	-0.49	-0.58
YPH		1	-0.11	-0.62	0.58	-0.21	0.63	0.83	0.56
SH4O			1	-0.04	0.22	-0.06	0.20	-0.07	0.21
ADI				1	-0.65	-0.05	-0.89	-0.68	-0.55
SR					1	-0.13	0.76	0.67	0.48
FPL						1	-0.14	-0.33	-0.05
LEB							1	0.73	0.62
UR								1	0.52
DT									1

Table 6-7

Analysis of Multicollinearity in the Basic Model

Collinearity in the Fertility Equation (TSLS Procedure)			Collinearity in the Fertility Equation (General Procedure)			Collinearity in the Reduced Form (General Procedure)		
Dependent Variable	R'	F-test (6,26)	Dependent Variable	R'	F-test (6,26)	Dependent Variable	R'	F-test (11,20)
YPH	0.65	7.7	YPH	0.56	5.4	YPH	0.84	11.37
$SH4O_p$	0.55	5.1	SH4O	0.22	1.2	ADI	0.84	11.37
ADI	0.95	95.5	ADI	0.86	27.1	SR	0.62	3.48
SR	0.77	13.8	SR	0.60	7.4	RG	0.31	0.96
FPL_p	0.44	2.9	FPL	0.27	1.6	ASH	0.86	13.2
LEB_p	0.999	**	LEB	0.91	43.2	DT	0.6	3.4

General Procedure: succesive regressions are run among the explanatory variables; one of them is chosen as dependent and the remainder as independent variables.

TSLS Procedure: same principle as above, but using the predicted value of the variable in the first stage of the TSLS procedure, where it corresponds.

Subscript P: means predicted value

R' and F= multiple corelation coefficient and test F for each regression.

The dummy variables were used only as independent variables.

Sample size = 32.

** computer symbol for an extreme high value of the test F

There is no easy solution to the multicollinearity problem. On the one hand, it is impossible to further expand the sample because of the data constraint. On the other hand, to eliminate ADI or LEB is not a real solution. The elimination of ADI in the fertility equation produces the correct signs for all the variables, and SR could be regarded as the educational variable. However, such re-estimated coefficients may be biased due to the elimination of the relevant determinant ADI. Another solution, explored later, is the expansion of the system or the endogenization of income and other variables.[35]

A different solution would have been the use of infant mortality instead of life expectancy and of the female illiteracy rate instead of the adult illiteracy rate. However, this solution was inconsistent with two postulations of the model--namely, the greater importance of adult education in comparison with female education as a determinant of fertility, and the corresponding more global importance of life expectancy in comparison to infant mortality.[36]

6.2.4.3 Exploratory Hypotheses

The hypothesis of a negative effect of income distribution on the female participation rate, associated with Flegg (1979), was rejected. Different attempts to prove the validity of such a hypothesis were made: by using non-linear forms; by using the Gini coefficient instead of SH40 as the proxy for income distribution; by changing the sample size; and, ultimately, by testing the SH40 effect on the female participation rate in the expanded model of eight equations. None of these attempts was successful.

---

[35] See Koutsoyiannis (1977, p. 251), for the use of additional equations as a solution for multicollinearity.

[36] In addition, there was less data on infant mortality than on life expectancy. Finally, the use of the female illiteracy rate was inconsistent with the incorporation of a production function in the model, which was done later.

The statistically insignificant positive coefficient of the crude birth rate in the life expectancy equation seems to us to reject the Repetto (1979) hypothesis of a negative relationship. It seems that Repetto misspecified his equation of infant mortality by omitting the income and income distribution explanators.[37]

6.3 Changes in the Specification of the Basic Model

The marginal significance of the direct effect of income distribution on fertility provided only weak support to the main hypothesis of this research.[38] In addition, the rejection of the hypotheses of negative direct effects of income distribution on the female participation rate and that of fertility on life expectancy--besides their unexpected signs--impaired the analysis of the multipliers.

In the light of these limitations, the basic model was modified and re-estimated. This modification (hereafter, called "modification one") involved the following changes. First, in accordance with the afore rejected hypotheses, income distribution was not considered a determinant of the female participation rate, nor the crude birth rate a determinant of life expectancy. In addition, income distribution was no longer considered an endogenous variable.

---

[37] Such a procedure provides a statistically significant result for the CBR coefficient, but it is likely to be biased.

[38] The t-value asocciated with the SH40 coefficient was only 1.42.

The reasons for treating income distribution as exogenous to the system are more practical in nature than theoretical. Firstly, the endogeneity of income distribution in the system entails a high cost in terms of the stability and the level of significance of the corresponding estimates, in general, and that associated with SH40 in the structural equation of fertility, in particular. Some of the exogenous determinants of income distribution contribute to the high multicollinearity embedded in the basic model. This affects the stability of the estimates. When SH40 is taken to be exogenous and, hence, those of its explanators that are different from the remaining exogenous variables in the system are eliminated, the degree of multicollinearity is significantly reduced. Consequently, the quality of the TSLS estimates is markedly improved. This effect can be checked by examining Table 6-7 where it is shown that ASH, an explanator of SH40, is the exogenous variable most affected by multicollinearity in the basic model.

Secondly, the exogeneity of income distribution greatly facilitates the derivation of multipliers which are required in order to be able to show in a clear cut way the total effect of income distribution on fertility. In the basic model, this was not really a problem given the simplicity of the model which allowed an indirect approach to infer such a total effect. However, for analyzing additional aspects of the income distribution relationship with fertility, as is done later, the endogeneity of income distribution certainly impairs the analysis. [39]

In quantitative terms, the cost of exogenizing income distribution is the loss of potential reinforcement for the multipliers of those exogenous variables which directly affect fertility negatively. This is so because the direct effect of fertility on income distribution, which is negative in sign, is not captured in the new specification of the model. The magnitude of this potential cost, however, is not that important (given the analysis in section 6.2.3.3). In addition, it must be recalled that the hypothesis of a negative effect of fertility on income distribution, the main reason for the endogeneity of income distribution, was not strongly supported by statistical evidence. This is manifested in the associated t-ratio which was relatively low (-0.7).

---

[39] In analyzing the total effect of an endogenous variable upon another endogenous variable "intercept multipliers" could have been used (Gregory, 1972). However, these multipliers have a less clear economic interpretation.

6.3.1 The Results of Modification One

In Table 6-8 are reported the TSLS estimates for the equations of fertility, life expectancy and the female participation of the two system specifications: the basic model and the present modification.

In the fertility equation, the rise in the level of significance of the SH40 coefficient is noticeable. Indeed, the size of the coefficient times its standard error rises from 1.4 times its standard error as estimated in the basic model to 2.2 times in this new specification. Some minor improvement is also obtained in the coefficient associated with YPH. The new specification, however, does not solve the problem of the wrong sign of ADI. In the life expectancy equation, the new specification produces an improvement in the coefficient associated with DT. Finally, in the female participation rate equation, there is a noticeable improvement in all the estimates. In particular, the coefficient associated with the CBR improves markedly. In summary, the results of the new specification confirm statistically the essential components of our model. That is to say, they ratify the existence of a significant negative direct effect of income distribution on fertility, a direct positive effect of income distribution on life expectancy and a negative direct effect of fertility on the female participation rate.

In Table 6-9 we report the TSLS estimates for the direct and total effects, as well as for direct and total

Table 6-8

Comparison of TSLS Estimates between the Basic Model and Modification One

Fertility Equation: CBR			Life Expectancy Equation: LEB			Female Part. Rate Equation:FPL		
Variables	B. Model TSLS	Modif. One TSLS	Variables	B. Model TSLS	Modif. One TSLS	Variable	B. Model TSLS	Modif. One TSLS
Constant	114.6	114.05	Constant	53.37	53.79	Constant	0.39	0.41
	(2.43)*	(1.72)**		(3.96)*	(6.64)*		(2.45)*	(4.7)*
YPH	-0.0059	-0.0078	YPH	0.00046	0.0032	YPH	0.000094	-0.0001
	(-1.17)	(-1.57)**		(1.32)**	(1.08)		(-1.54)**	(-1.9)*
SH40	-47.37	-56.9	SH40	49.51	27.87	SH40	0.0022	
	(-1.41)**	(-2.2)*		(2.36)*	(1.95)*		(0.0053)	
ADI	-11.37	-11.45	ADI	-25.9	-25.97	X	-0.15	-0.15
	(-0.63)	(-0.4)		(-6.06)*	(-7.54)*		(-3.66)*	(-4.4)*
SR	-19.1	-20.28	CBR	0.028		CBR	-0.0028	-0.0033
	(-1.38)**	(-1.15)		(0.18)			(-1.066)	(-1.73)*
LEB	-0.87	-0.78	DT	0.054	0.0857	X7	0.077	0.078
	(-1.13)	(-0.75)		(0.58)	(1.03)		(2.64)*	(2.7)*
FPL	-26.85	-36						
	(-1.84)*	(-1.86)*						

Table 6-8a

Comparison of TSLS Estimates between the Basic Model and Modification One

Fertility Equation: CBR			Life Expectency Equation: LEB			Female P.Rate equation: FPL		
Variables	B. Model TSLS	Modif. One TSLS	Variables	B. Model TSLS	Modif. One TSLS	Variables	B. Model TSLS	Modif. One TSLS
X4	-10.57	-9.7						
	(-2.57)*	(-1.95)*						
R^2	0.73	0.72	R^2	0.84	0.84	R^2	0.59	0.59

* Significant at 5% level or less.

** Significant at 10% level.

Sample Size = 32.

Table 6-9

Selected Direct and Total Elasticities--Modification One

(TSLS Based)

Exogenous Variables	Endogenous Variables Fertility : CBR		Life Expectancy : LEB		Female Participation : FPL	
	Direct Elasticity	Total Elasticity	Direct Elasticity	Total Elasticity	Direct Elasticity	Total Elasticity
YPH	-0.085	-0.08	0.023	0.023	-0.165	-0.12
SH40	-0.19	-0.28	0.06	0.06	-	0.149
ADI	-0.11	0.09	-0.17	-0.17	-	-0.033
SR	-0.14	-0.16	-	-	-	0.08
DT	-	-0.19	0.14	0.14	-	0.1

elasticities. The total effects, or multipliers, of education are strongly biased. In particular, the total elasticity of fertility with respect to the adult illiteracy rate is biased downwards.[40] The total elasticity of fertility with respect to income distribution is -0.29 while the corresponding direct elasticity is -0.19. That is, the total effect of income distribution on fertility is about 1.5 times its direct effect. The indirect effect is mostly explained (66%) by the total effect of income distribution on life expectancy and certainly by the high direct elasticity of fertility with respect to life expectancy (-1.17). In the basic model the indirect estimate of the total elasticity of fertility with respect to income distribution was -0.28 and the corresponding direct elasticity was -0.15. A simple comparison between these two multipliers (-0.28 versus -0.29) suggests that the cost associated with the elimination of the SH40 equation was not that high.[41]

The estimate for the multiplier of education on fertility is unsatisfactory. Ultimately, the cause of that poor result is the high collinearity between ADI and LEB. When discussing the multicollinearity problem, it was argued that the elimination af any of those two variables did not constitute a real solution to the problem. Eliminating ADI from the system and replacing it by SR, the secondary enrolment ratio, as the only proxy for education in the system, appeared to be an apparent solution to the problem. The cost associated with this alternative, however, was an upward bias in the estimates of the structural coefficients of the fertility equation, and a downward bias for the direct effect of education on fertility. In terms of the multipliers, the cost was a consequent downward bias in the total effect of income distribution on fertility and, to a lesser degree, on that of education. Despite these qualifications, re-estimating the system using the above solution was useful in terms of illustrating the total effect of education in a more realistic way. The TSLS results of "modification one" using SR as the only proxy for education are reported in Table 6-10.[42]

---

[40] The multipliers of education are distorted due to the wrong sign associated with the coefficient of ADI in the structural equation of fertility. To the extent that such a wrong sign does not imply a distortion in the rest of the structural coefficients of such an equation, it follows that the multipliers of the other exogenous variables are not distorted.

[41] It is difficult to do a statistical comparison, given the difficulties involved in obtaining the standard errors for the total effects.

The total elasticity with respect to education, proxied by SR only, is equal to -0.28 while the correspondent direct elasticity was -0.20. In turn, the total elasticity of fertility with respect to income distribution was -0.23 with a direct elasticity of -0.21. The minor difference between the direct and total effects in this case reflects the upward bias in the estimates of the structural parameters in

---

[42] Recall that in the basic model SR was not used in the life expectancy equation. It was argued that such a variable was mainly a proxy for the cost of children. Nevertheless, it is impossible to deny that such a variable must also capture some of the effects of education.

Table 6-10

TSLS Estimates of Modification One -- Using SR as a Proxy For Education

	Fertility			Life Expectancy			Female Participation Rate	
	CBR			LEB			FPL	
Var.	Coeff.	t-value	Var.	Coeff.	t-value	Var.	Coeff.	t-value
Constant	80.4	5.11*	Constant	24.1	2.42*	Constant	0.40	4.6*
YPH	- 0.0085	-1.68**	YPH	0.0052	1.19	YPH	-0.000098	-1.86*
SH40	-63.93	-3.01*	SH40	8.92	0.41	CBR	-0.0031	-1.6**
SR	-27.626	-2.14*	SR	32.6	3.66*	X,	0.077	2.69*
LEB	- 0.25	-0.75	DT	0.21	1.83*	X	-0.15	-4.43*
FPL	-29.551	-2.22*						
X,	- 7.77	-1.94*						
	R'=0.75			R'=0.85			R'=0.619	

* Significant at 5% or less - 2 tail test.

** Significant at 10% level - 1 tail test.

Sample size = 32.

the fertility equation, and the downward bias in the life expectancy equation.[43]

Nevertheless, in spite of the above qualifications the estimated SR multiplier on fertility more accurately reflects what may be the real total effect of education on fertility.

6.4 The Expansion of the Demographic-Economic Analysis

In this section, the analysis of economic and demographic variables depicted in the previous model specification (modification one) is extended to include the influence of income per-head, the dependency rate, the total labour participation rate, the savings rate, and the rate of growth of GDP. These five additional variables are taken to be endogenous.

This extension of "modification one" constitutes a simplified version of the Gupta (1982) model of demographic pressures on savings and economic growth.[44] In particular, the Gupta (1982) model is adapted to our three equations for fertility, life expectancy, and the female participation rate. The modifications applied to the Gupta model were meant to allow for a more direct focus on the central point of this study--namely, the effect of income distribution on fertility.

---

[43] Certainly, this result is related to the fact that ADI, the illiteracy rate, must be a more important determinant of life expectancy in LDCs than SR.

[44] In addition, the new specification also takes into account in an important way the model of Gregory (1972) and particular points associated with the work of Repetto (1979), Flegg (1979), Ram (1982), Gupta (1971, 1975, 1983), Rodgers (1979), Bilsborrow (1973, 1979), and the survey of Mikesell (1973).

The rationale for extending the model relates mainly to the consequences, for the relationship between income distribution and fertility, of the endogenization of income per-head. The income distribution multiplier is likely to be reinforced by this new specification. Income per-head is specified as a positive function of the total labour participation rate and education. The total labour participation rate, in turn, is specified as a positive function of income per-head and a negative function of the dependency rate. Finally, the dependency rate is specified as a positive function of both fertility and life expectancy. Therefore, in this new specification, income distribution improvements are ultimately positively related to income per-head. In turn, an increase in income feeds back in further fertility reduction.

Such a reinforcement of the multiplier can also apply for the multiplier of education on fertility. However, income per-head is also specified as directly dependent on education. This implies, on the one hand, that such a multiplier is likely to be greater than the respective multiplier of income distribution. On the other hand, it is also possible that a strong direct effect of education on income per-head implies an important counter effect to the fertility decline induced by an improvement in education. Such a counter effect is given by the reduction in the female participation rate induced by a higher income.

The additional equations for savings and the rate of economic growth are useful for analyzing the costs associated with an income distribution policy. This subject, however, goes beyond the scope of this research, and thus will be analyzed only marginally.[45]

6.4.1 The Specification of the Additional Equations

This adaptation of the Gupta (1982) model (hereafter called for practical purposes the expanded model) includes eight equations. Three of them : fertility, life expectancy and the female participation rate, are basically the same as in "modification one". The only change is that the illiteracy rate (ADI) has been replaced by the literacy rate (LIT) in the equations of fertility and life expectancy. The purpose of doing this is simply to clarify the analysis--specifically, to use LIT instead of ADI in the aggregate production function or income per-head equation.[46] The five additional equations of income per-head, total labor participation rate, dependency rate, savings ratio, and the rate of economic growth are specified as follows.

---

[45] For a discussion on the subject, see Gupta (1971, 1975, 1982, 1983), Leff(1969, 1971, 1974), Bilsborrow (1973, 1979), Mikesell (1973) and a large literature on the subject which would be too long to reproduce here.

[46] The two variables of education, LIT and SR, in the fertility equation are retained initially. Also, as discussed before, income distribution is treated as exogenous.

Income per Head

(4) $YPH = c_1 + c_2EC + c_3TLP + c_4LIT + c_5PD + e_4$

Total Labour Force Participation Rate

(5) $TLP = e_1 + e_2YPH + e_3DR + e_4X_7 + e_5$

Dependency Rate

(6) $DR = h_1 + h_2LEB + h_3BR + e_6$

Savings Ratio

(7) $SVR = f_1 + f_2YPH + f_3RG + f_4SH40 + f_5DR + f_6F + e_7$

The Rate of Economic Growth

(8) $RG = g_1 + g_2SVR + g_3F + g_4LIT + g_5GL + e_7 + e_8$

The functional form of the system is linear in order to allow comparison with the previous models.

Additional Endogenous Variables

DR = dependency rate. Defined as the ratio of the "inactive" population (0-15 years plus 65 +) over the "active" one (that from 15-65 years old).

TLP = total labour force participation rate

SVR = gross domestic saving rate. That is, aggregate savings over GDP, calculated as the average of the annual rate in the 1965-73 period.

RG = rate of growth of GDP, calculated as the average annual rate in the 1965-73 period

Additional Exogenous Variables

LIT = literacy rate of the adult population

GL = annual rate of growth of the labour force.

Calculated as the annual average between 1965 and 1973.

EC = energy consumption per capita, measured in kilograms per capita coal equivalents

PD = population density--total population per square km. of agricultural land

F = capital inflow proxied as the percentage of the deficit on current account over GDP. It was calculated as an annual average between 1965-1973.

The Additional Equations

Income Per Head

Income per head was specified as a positive function of capital per head--proxied by energy consumption per capita (EC) in coal kgm. equivalents, the total labour force participation rate (TLP), and quality of labor--proxied by the adult literacy rate (LIT), and as a negative function of population density (PD) (Gregory, 1972; Hazeldine, 1977; Gupta, 1982).[47] The signs of EC, TLP and LIT were expected to be positive and PD negative, in our case of LDCs.

The Total Labour Force Participation

The total labour participation rate was specified as a negative function of the dependency rate, a positive function of X_7, and also as dependent on YPH. The effect of YPH on the total labour participation rate was unsigned (Gupta, 1982; Gregory,1972).[48]

---

[47] Income per head or production per head comes explicitly from assuming that income, of each country, can be treated as a production function. This function has capital, labor, quality of labour, and agricultural resources as arguments. Assuming that this production function is homogeneous of degree one, then we can express income per capita as a function of the above mentioned arguments in per capita terms. See Gregory (1972).

The Dependency Rate

The dependency rate (DR) is basically a demographic phenomenon; as such, it was specified as a positive function of both the birth rate and life expectancy. These two variables, though, affect differently the composition of the dependency rate. An increase in life expectancy raises the weight of "old dependents" in the DR, while an increase in the crude birth rate raises the weight of the young dependents (Keyfitz, 1968).

The Savings Rate

Following Gupta (1982) and Ram (1982), the savings rate is defined as a positive function of income per-head, the rate of growth of GDP and as a negative function of income distribution (SH40) and capital inflows (F). The dependency rate (DR) is also included as an explanator; however, its effect is unsigned (Gupta,1975, 1983; Bilsborrow 1979; Cline, 1972; Leff, 1969, 1984).

The Rate of Economic Growth

Following Gupta (1982), the rate of growth is defined as a positive function of savings (SVR), capital inflow (F), the rate of growth of the labor force (GL), and labor force quality proxied by LIT.

---

[48] Increases in YPH alter the composition of the labor force, but the aggregate effect of such increases is ambiguous. It can be argued that a rise in household income, proxied by YPH, tends to increase the male participation rate and to decrease the participation of married women. In LDCs, however, increases in household income should also reduce the participation of children in the labor force.

6.4.2 The Results of the Demographic-Economic Analysis

The TSLS estimates of the expanded model are reported in Table 6-11.

With respect to the three first equations--fertility, life expectancy and the female participation rate, it would be redundant to go through a detailed analysis. It is sufficient to say that their structure remains the same as that estimated in the previous specifications. That is, the signs associated with the structural parameters in these equations remain the same as in the basic model and in "modification one".

It is important, however, to analyze the changes in the level of significance of the structural coefficients of these three equations resultant from this new specification with respect to "modification one". This comparison is summarized in Table 6-12.

In the fertility equation the specification of the expanded model produces a better result for the coefficient associated with life expectancy which becomes marginally significant. In the rest of the estimated coefficients there are no major changes.

In the life expectancy equation, the result for the income coefficient is markedly less significant in the expanded model while the result for DT, the level of calorie

Table 6-11

Two Stage Least Squares Estimates of the Expanded Model

Fertility			Life Expectancy			Female Participation Rate			Income Per Head		
	CBR			LEB			FPL			YPH	
Variable	Coeff.	t-value	Variable	Coeff.	t-value	Variable	Coeff.	t-value	Variable	Coeff.	t-value
Constant	122.58	3.25*	Constant	25.8	3.6*	Constant	0.39	4.9*	Constant	13.73	0.064
YPH	-0.0072	-1.26	YPH	0.0008	0.24	YPH	-0.00007	-1.42**	EC	0.26	6.91*
SH40	- 50.2	-1.97*	SH40	24.53	1.68**	CBR	-0.003	-1.76**	TLP	0.6	0.11
LIT	22.2	0.98	LIT	27.24	7.63*	X	-0.15	-4.25*	LIT	399	3.55*
SR	- 14.2	-0.79	DT	0.11	1.32**	X_1	0.084	2.86*	PD	-0.19	-2.53*
FPL	- 44.6	-2.2*									
LEB	- 1.25	-1.39**									
X_4	- 11.31	-2.49*									
	R^2=0.67			R^2=0.84			R^2=0.59			R^2=0.82	

* Significant at 5% level or less-2 tail test.

** Significant at 10% level-1 tail test.

Sample size = 32.

Table 6-11a

Two Stage Least Squares Estimates of the Expanded Model

	Savings Rate			Rate of Growth			Total Participation			Dependency Rate	
	SVR			RG			Rate: TLP			DR	
Var.	Coeff.	t-value	Var.	Coeff.	t-value	VAr.	Coeff.	t-value	Var.	Coeff.	t-value
Constant	20.01	1.59**	Constant	1.65	0.65	Constant	48.8	6.9*	Constant	-1.02	-1.48**
YPH	0.0051	1.59**	SVR	-0.016	-0.107	YPH	0.0024	0.72	CBR	0.039	4.09*
RG	2.22	2.89*	F	-0.056	-0.21	DR	-12.447	-3.28*	LEB	0.0212	2.76*
SH40	-34.05	-1.61**	LIT	2.46	1.25	X,	5.9	2.73*			
DR	- 8.32	-1.83**	GL	1.36	1.8**						
F	- 0.601	-1.63**									
	$R^2=0.32$			$R^2=0.18$			$R^2=0.69$			$R^2=0.27$	

Table 6-12

Comparison of t-Ratios in The Demographic Equations

between Modification One and The Expanded Model

	Fertility			Life Expectancy			Female Participation Rate	
	M1	EM		M1	EM		M1	EM
Var.	t-value	t-value	Var.	t-value	t-value	Var.	t-value	t-value
Constant	1.72*	3.25*	Constant	6.6*	3.6*	Constant	4.7*	4.9*
YPH	-1.57**	-1.26	YPH	1.08	0.2	YPH	-1.9*	-1.42**
SH40	-2.2*	-1.97*	SH40	1.95*	1.68**	CBR	-1.73**	-1.76*
ADI	-0.24	-0.98	ADI	-7.5*	-7.63*	X	-4.4*	-4.25*
SR	-1.15	-0.79	DT	1.03	1.32**	X.	2.7*	2.86*
LEB	-0.75	-1.39**						
X_4	-1.95*	-2.49*						
FPL	-1.86*	-2.2*						

* Significant at 5% or less - 2 tail test.

** Significant at 10% level - 1 tail test.

M1 means modification one.

EM means expanded model.

intake, is markedly more significant than in "modification one".

Finally, in the female participation rate equation the estimate for the income per-head coefficient is somewhat less significant than in "modification one".

In summary , the important changes occur in the life expectancy equation. Only one of these changes, the statistical insignificance of income in such an equation, is disturbing for the model. However, the main hypotheses related to the income distribution multiplier remain robust. That is, the income distribution coefficient in both the fertility and life expectancy equations are associated with a reasonable level of significance. This is also true for the coefficient of the crude birth rate in the female participation rate equation. A pattern seems to be that the simultaneity bias is important in the case of income. That is, when such variable is endogenized, an important reduction in the coefficients associated with income through the system should be expected. Another interpretation could be an increase in the degree of collinearity as an unexpected outcome of the system expansion.

Secondly, we concentrate upon the analysis of the results for the relevant additional equations: total labour participation, the dependency rate and income--Table 6-11.

The results of the total labour participation rate equation are encouraging. In fact, DR, the dependency rate, affects TLP negatively, and X_7 affects it positively. The respective coefficients are strongly significant. The sign of YPH, income per-head, denotes that its net effect on the total labour participation rate is positive. Notice that the composition of the labour force, however, changes; in fact, the female participation rate decreases when income rises. These results are in agreement with the findings in other research (Gupta, 1975, 1982; Gregory, 1972, 1976).

In the dependency rate equation, both of the explanators, fertility and life expectancy, affect positively, as hypothesized, the dependency rate. Both results are strongly significant.

In the income equation all the coefficients, except for that associated with the total labour participation rate, are statistically significant. As well, all the signs are the expected ones. That is, the sign of the proxy for capital per head (EC) is positive, as well as the sign for the proxy of labour-force quality (LIT) and that for the total participation in the labour force (TLP). The sign of the proxy for population pressures on agricultural resources, PD, is negative. These results are in agreement with Gupta (1975, 1982) and Gregory (1972).

Our result for the total labour participation rate coefficient, however, is indeed too weak--the associated t-ratio is only 0.11. This latter result weakens the argument for any change in the income distribution multiplier on fertility as a consequence of the income per-head endogenization. It suggests that the link between declines in fertility and an income increase, does not hold for this case. The relevance of such a result for our analysis raises a question about the validity of this result. On the one hand, it can be argued that the total labour force participation variable is poorly measured, especially in LDCs.[49] On the other hand, the significant results for the rest of the determinants in the income equation, the marked absence of collinearity in this case[50] and the confirmation of the inexistence of a positive effect of TLP on YPH using the more appropriate double-log form, suggest that labour indeed may be not that productive in LDCs.

The above discussion of the preceding six equations contains all the information required (structural coefficients) in order to proceed to the multiplier analysis of the demographic side of this model. The discussion of the savings and rate of growth equations not relevant for such a demographic analysis is postponed.[51]

---

[49] See Schultz (1981) for a discussion about the quality of labour force data.

[50] The highest correlation found between the TLP and any of the rest of the explanators in the income equation was -0.37.

[51] The adaptation of Gupta's (1982) model used here has characteristics of recursivity. That is, fertility, life expectancy, the female participation rate, and the total labour participation rate influence savings through income and the dependency rate. And they influence the rate of growth through savings. However, the reverse does not happen. Neither savings nor the rate of growth feed back in any of the above six equations. Therefore, the strict demographic analysis can be carried on without the information contained in the savings and rate of growth equations.

The TSLS estimates for the reduced form equations are reported in Table 6-13. Some selected elasticity multipliers are reported in Table 6-14. Instead of analysing all the multipliers, we concentrate on those relevant for the demographic aspects of the model.

The total elasticity of fertility with respect to income distribution is now -0.31 while the correspondent direct elasticity is -0.16.[52] That is, the total effect is twice the direct effect. A strict statistical interpretation of this result suggests that this income distribution multiplier (-93) is not greater than that derived in "modification one" of the basic model (-89). This can be proved by testing the structural coefficient associated with TLP in the income equation, which as shown before, is not significantly different from zero.[53]

However, it is more illustrative to assume a less strict statistical interpretation and to show the qualitative insight provided by this new specification. (That is, to assume that the direct positive effect of TLP on YPH can be considered in the analysis, even though it is not statistically significant). In order to show such an insight, it is convenient to disaggregate the analysis of the income distribution multiplier.

---

[52] The qualification with respect to the multipliers are exactly the same as in "modification one".
[53] It can be demonstrated theoretically that if such a coefficient is zero, the new multiplier of income distribution on fertility reduces to that obtained in "modification one" of the basic model.

Table 6-13

TSLS Estimates of the Reduced Form Equations of the Expanded Model

Endogenous Variables	Exogenous Variables LIT	SR	SH40	X_4	PD	X	X.	EC	F	GL	DT	Constant
CBR	-16.25	-16.42	-93.00	-13.07	0.0011	7.73	-4.35	-0.15	0	0	-0.15	83.00
LEB	27.7	0.0038	24.5	0.003	-0.00015	-0.0018	0.0038	0.2	0	0	0.11	25.8
FPL	0.02	0.048	0.27	0.038	0	-0.17	0.096	-0.00001	0	0	0.00047	0.13
YPH	399	4.78	23.3	3.81	-0.19	-2.2	4.81	0.26	0	0	0.028	22.26
SVR	7.62	5.1	-7.65	4.11	-0.0012	-2.43	1.38	0.0017	-1.77	2.91	0.031	0.62
TLP	1.5	7.9	38.9	6.3	-0.0009	-3.7	8.02	0.13	0	0	0.04	14.26
RG	2.33	-0.082	0.12	-0.065	0.00002	0.038	-0.022	-0.000027	-0.53	1.31	-0.0004	1.64
DR	-0.046	-0.64	-3.12	-0.51	0.00004	0.301	-0.169	-0.55	0	0	-0.0038	278

Numbers are the estimated coefficients of the reduced form

The reduced form coefficients an obtained indirectly by using the TSLS estimates of the structural form coefficients.

Table 6-14
Selected Direct and Total Elasticities of the Expanded Model
(Based on TSLS Estimates)

Endogenous Variables	Exogenous Variables LIT	SH40	DT
CBR	-0.27	-0.31	-0.38
	0.36	-0.16	-
LEB	0.29	0.05	0.19
	0.24	0.05	-
FPL	0.05	0.13	0.18
	-	-	
YPH	0.61	0.07	0.0005
	0.60	-	-
TLP	0.02	0.15	0.12
	-	-	-
DR	-0.018	-0.26	-0.27
	-	-	-
SVR	0.27	-0.059	0.079
	-	-0.26	

The first number denotes total elasticity; the second, direct elasticity.

In the first place, let us analyse the effect of income distribution on income, and the meaning of this for the income distribution multiplier on fertility. The total elasticity of income with respect to income distribution is only 0.007. In addition, the direct elasticity of fertility with respect to income is also very low, -0.078. This illustrates the minor contribution of the induced rise in income to the final effect of income distribution on fertility.

Consequently, the existence of counter effects to the induced fertility decline, as suggested by the low total elasticity of income with respect to income distribution, are minimal or non-existent in this case. This means that the total elasticity of the female participation rate with respect to income distribution, which equals 0.13, is totally explained by the total effect of income distribution on fertility, and the induced increase in income does not play any role in such an effect. This can be confirmed by comparing the total elasticity multipliers of income distribution on fertility, the female participation rate and life expectancy obtained here with the correspondent elasticities of "modification one" where income is exogenous. These elasticities in the expanded model are -0.31, 0.13 and 0.05, respectively. In "modification one" they are -0.28, 0.14 and 0.06, respectively. That is, they are basically the same. Therefore, the elasticity multiplier of income distribution on the female participation rate is not counteracted by the induced increase in income. As well, the improvement in life expectancy is mainly explained by the direct effect of income distribution. Finally, by replacing the endogenous determinants of fertility (structural equation) by its correspondent reduced forms, it can be shown that the most important contribution to the indirect effect of income distribution on fertility is that occurring through life expectancy, and secondarily through the female participation rate. The contribution of income, as anticipated, is zero. It must be said, however, that the contribution through life expectancy is mostly explained by the direct elasticity of fertility with respect to life expectancy (-1.8), rather than by the income distribution effect on life expectancy itself.

Another more interesting finding is to compare the elasticity multiplier of DT, the calorie intake--which can be thought as a proxy for government nutrition programs--with the elasticity multiplier of income distribution on fertility. As shown in Table 6-14, the elasticity of fertility with respect to DT (-0.38) is greater than the corresponding income distribution elasticity multiplier (-0.31). The DT multiplier on life expectancy (0.19) is also greater than the corresponding income distribution multiplier (0.05). Consequently, the DT multiplier on the female participation rate, because of the above greater total effects, is also higher (0.18 and 0.13 respectively). The result is interesting for the following reasons. First, it highlights once more the crucial role of modifying life expectancy as an important policy aimed at reducing fertility in LDCs. Second, the improvement of the nutritional status of the majority in LDCs--the poor--can be considered as a less costly and more politically feasible measure than the alteration of the size distribution of income in LDCs (Todaro, 1985).

The nature of the multiplier of adult education (LIT) on fertility differs from that of the corresponding multiplier of income distribution (SH40). The difference is explained by the direct effect of adult education on income per-head. Both education (LIT) and income distribution (SH40) have a direct negative effect on fertility and a positive direct effect on life expectancy; however, only education has a direct positive effect on income per-head.

The increase in income per-head, associated with an educational improvement, reduces fertility--given the negative sign of income in the fertility equation--and improves life expectancy, thus, reinforcing the decline in fertility. On the other hand, the increase in income per-head induces a decline in the female participation rate, thus, increasing fertility. Therefore, the net effect on fertility associated with an increase in income--due to an educational improvement--will depend on which of the above forces predominates. If the net effect on fertility is negative, and the direct elasticities of both fertility and life expectancy with respect to education and income distribution are of the same magnitude, it follows that the total elasticity multiplier of education on fertility must be greater than the corresponding elasticity multiplier of income distribution.

The analysis of the involved direct elasticities suggests that this net effect is negative but small. A ten per cent increase in income should induce approximately a 0.34 percent increase in fertility, via the increase in the female participation rate, and a 0.79 percent decline in fertility, via the improvement in life expectancy and the direct effect of income on fertility. The direct elasticities of fertility with respect to income per-head, life expectancy and the female participation rate are -0.07, -1.8 and -0.29, respectively. The direct elasticities of the female participation rate and life expectancy with respect to income per-head are -0.12 and 0.005, respectively.

A direct comparison between the elasticity multipliers of education and income distribution on fertility is impaired because of an underestimation of the total effect of education (LIT) on fertility. This underestimation is a consequence of the wrong positive sign associated with the direct effect of education on fertility. The estimates for these multipliers are -0.27 and -0.31 for adult education and income distribution, respectively. The minor difference in their magnitude suggests that the elasticity multiplier of education on fertility must be at least as important as the corresponding income distribution elasticity multiplier.

Given the distortion associated with the use of LIT, it was attempted, as in "modification one", to reestimate the reduced forms by using SR as the only proxy for education in the system. SR performed well in all the equations; however, the sign associated with the total labour participation in the income per-head equation, though statistically insignificant, was negative. (This result changes all the logic of the analysis so these estimates were not used).

6.4.3 The Cost Associated with an Income Redistribution Policy

The results for the savings equation illustrate the associated cost of an income redistribution policy. Indeed, the existence of a significant negative direct effect of income distribution on savings indicates that such a policy may lead to lower capital formation and probably to a consequent decline in the growth rate. On the other hand, the negative direct effect of the dependency rate on savings suggests that a more equal income distribution, through a decline in fertility, could offset the initial negative indirect effect of income distribution on savings. The total elasticity of savings with respect to income distribution was -0.059 while the correspondent direct elasticity was -0.26. This result suggests that there is a possibility that the cost of an income redistribution policy in terms of savings is not that important. The estimate with respect to income distribution multiplier on the rate of growth was dismissed given the distortion implied by the wrong signs in the rate of growth equation. On the other hand, the topic is more complex and goes beyond the scope of this thesis and this particular simplified model. Therefore, it can only be suggested that there is a possibility that the negative direct effect of income distribution on savings could be offset by the effect of income distribution on the dependency rate.[54]

---

[54] For a further discussion on the topic, see Gupta (1971, 1975, 1985).

7. SUMMARY AND CONCLUSIONS

The study found supportive evidence for Repetto's hypothesis of a direct negative effect of income distribution on aggregate fertility in less developed countries. The hypothesis in question proved to be robust and consistent. That is, the hypothesis was tested and verified using different system specifications; using the linear and double-log functional forms; and, finally, using different sample sizes.

The confirmation of that hypothesis overcomes two criticisms of Repetto's work raised by Flegg (1979) and Birdsall (1981). Namely, the dependence of Repetto's results on the predominance of developed countries in his sample and the omission of relevant determinants of fertility as well as incomplete attention to simultaneous equation problems in his model. To overcome these difficulties, this study used a sample constituted exclusively of LDCs and analyzed the more relevant simultaneities related to fertility.

It is important to acknowledge that the sample used could be considered more representative of high income less developed countries. That is, even though the sample includes countries from the lowest categories of per-capita income such as Bangladesh, Tanzania and Sierra Leone, it has a predominance of middle and high income LDCs such as the Latin American countries. In any event, the size and composition of the sample was constrained by the availability of income distribution data.

The measure of income inequality used herein was the share of the bottom forty percent of households in the GNP (SH40). This measure proved to be more significantly related to fertility than the Gini index. For instance, in two of the samples analyzed, the t-ratios associated with the effect of SH40 on fertility were -1.97 and -2.09 while the corresponding t-ratios associated with the Gini were 1.08 and 1.58, respectively. The superior perfomance of SH40 must be related to our contention that this measure proxies absolute inequality besides being a measure of relative inequality--when income is kept constant in the analysis.

The direction of causality in the relationship between income distribution and fertility was confirmed for one way only. That is, the negative effect of income distribution on fertility was strongly supported by evidence while the reverse causality proved to be weak. In the latter instance, the coefficient associated with the effect of fertility on income distribution, although having the correct sign, was not statistically significant.

It is possible, however, that the latter coefficient was affected by collinearity. Also, it must be said that the existence of such a negative effect is highly possible (World Bank Report, 1984; Bilsborrow, 1979) in spite of the weak evidence presented herein. Certainly, the existence of such a negative effect would also reinforce a fertility decline induced by an improvement in income distribution.

7.1 The Effects of Income Distribution on Fertility

The importance of the direct effect of income distribution on fertility, in general, was the same as that of the female participation rate--the corresponding direct elasticities associated with these two variables are in the range of -0.16 to -0.20. These impacts are subtantially lower than the direct effect of life expectancy. For instance, the direct elasticity of fertility with respect to life expectancy varied from -1 to -1.8 in the different system specifications used. The comparison with the direct effect of education was impaired by a distorted sign associated with the effect of the adult illiteracy rate on fertility. However, when this latter variable was dropped from the fertility equation and education proxied only by the secondary school enrolment ratio, the direct effect of education on fertility was the same as that of income distribution.

The real importance of income distribution in affecting fertility, however, must be judged by its total effect, or multiplier, on fertility. Indeed, income distribution also has an indirect negative effect on fertility which reinforces its direct effect. The results suggest that the magnitude of the total effect of income distribution on fertility may be about one and a half times to twice its direct effect. The elasticity multiplier of income distribution on fertility ranged from -0.27 to -0.31, depending on the models used.

Most of the indirect effect of income distribution on fertility is apparently explained by its direct positive effect on life expectancy. It must be clarified, however, that the above effect, rather moderate by itself, is magnified by a powerful effect of life expectancy on fertility. That is, the direct elasticity of life expectancy with respect to income distribution is about 0.05 while the direct elasticity of fertility with respect to life expectancy is approximately -1.5. The rise in the female participation rate induced by the fertility decline also contributes to such an indirect effect. However, given that the increase in the FPL is a consequence of the decline in fertility itself, its role in explaining the afore indirect effect is less important.

Therefore, in this study, the two crucial effects explaining the multiplier of income distribution on fertility are the direct positive effect of income distribution on life expectancy and the negative direct effect of fertility on the female participation rate discussed above.

Other hypotheses related to the magnitude of the income distribution multiplier on fertility were analyzed. The hypothesis of a negative effect of income distribution on the female participation rate, an effect which would have offset partially the indirect negative effect of income distribution on fertility reduction, was rejected in this study. In fact, such an effect, besides being statistically insignificant, had the wrong sign. Contrary to the hypothesis, such a positive sign would imply that the direct effect of income distribution on the female participation rate would reinforce the income distribution multiplier on fertility. Flegg (1979)--using Atkinson's index of inequality, a similar equation for the female participation rate and a two equation simultaneous system--found supportive evidence for the above hypothesis. The different results could be explained by the fact that our sample, given its smaller size in comparison with Flegg's sample, does not capture the non-linear relationship between the female participation rate and income per head, on which the hypothesis is based. Another explanation could be the different measures of income inequality used.

The hypothesis of a negative direct effect of fertility on life expectancy was also rejected in this research. The existence of this effect would have also reinforced the decline in fertility induced by an improvement in income distribution. Repetto (1979) used an analogous hypothesis of a positive effect of fertility on infant mortality. His result, however, was also non-significant.

In the expanded model (adapted from Gupta, 1982), the consequences for the income distribution multiplier on fertility associated with the endogenization of income per-head were analyzed. The hypothesis of a direct positive effect of the total labour participation rate on income per-head was not significantly different than zero in this study. This result suggests that a reduction in fertility, induced by a more equal income distribution, even though it increases the total labour force participation, does not affect income per-head in LDCs. Thus, a more equal distribution of income does not affect income per-head. Hence, the elements of the income distribution multiplier on fertility remain the same as before.

The above result is debatable and could be caused by the poor quality of data on total labour force participation. In any event, a significant impact of the total labour force participation rate on income per-head and a higher corresponding elasticity might be found in other studies of LDCs. In such a case, the income distribution multiplier on fertility may be somewhat reinforced. That is, the induced increase in income reduces fertility by itself and also improves life expectancy, thus reinforcing the above reduction. These two effects outweigh the rise in fertility due to the decline in the female participation rate, which is induced in turn, by the increase in income.

7.2 Policy Evaluation

The endogenization of income per-head, when income per-head is also defined as a positive function of adult education, has interesting implications for the multiplier of education on fertility. It provides useful elements for the evaluation of income redistribution as a policy tool towards the target of fertility reduction.

Even though reductions in fertility do not ultimately increase income per-head, improvements in education directly increase it. This effect happens to be very important--the estimated direct elasticity of income with respect to education (LIT) is about 0.6. In addition, an improvement in education should directly reduce fertility and improve life expectancy. In turn, the effect of adult education on life expectancy is markedly greater than the corresponding effect of income distribution. Therefore, it is likely that the multiplier of education on fertility may be greater than that of income distribution.

Unfortunately, a problem of multicollinearity affecting the sign associated with adult education in the fertility equation could not be solved. Thus, the multiplier of adult education on fertility remained underestimated. However, in spite of this underestimation, the minor difference between the total elasticity multiplier of education and that of income distribution (-0.27 for education and -0.31 for income distribution) illustrates the above argument.

Another criterion for the evaluation of an income redistribution policy aimed at reducing fertility, in addition to the total effect of income redistribution on fertility, must be to take into account its total effects on other relevant variables. In this sense, it may be important to consider the potential negative effect of income redistribution policies on savings formation (Cline, 1978).

The estimated total elasticity multiplier of income distribution on savings formation was -0.059 which is likely not that high a cost in term of savings. However, in comparison, the total elasticity multiplier of education on savings is 0.27. From this point of view, the advantages of an educational policy aimed at reducing fertility are obviously superior compared with those of an income redistribution policy.

Another possible policy for reducing fertility could be to increase the nutritional status of the population. The total elasticity multiplier of DT, , the average calorie intake, on fertility was -0.38 while the corresponding elasticity multiplier of income distribution was -0.31 (using measures of the expanded model). The improvement of DT can be thought of in terms of governmental efforts for improving the nutritional status of the population, as well as a redistribution of consumption.

Given the afore mentioned elements, a policy of income redistribution targeted to reduce fertility must be cautiously evaluated.

In the first place, educational improvement seems to have a much higher pay-off than an income redistribution policy. That is, an improvement in education must reduce fertility at least to the extent that a more equal distribution of income does. On the other hand, for the reasons discussed before, and contrary to what seems to be the case with income redistribution, education may be considered an investment rather than a cost. Second, there are other possible alternatives which may be less costly and probably more efficient in the case of less developed countries, as the above mentioned nutritional policy.

In addition, there are political arguments. That is, a redistribution of income is often not considered as a possible policy in LDCs because of strong political opposition (Todaro, 1985). However, a policy of education improvement, especially, and a policy of nutritional improvement may face less resistance.

However, this sort of evaluation comes from our restrictive modeling of reality. Paraphrasing Simon (1976), it is difficult to think that an important improvement in education and in the nutritional status of the population in LDCs can be achieved without a substantial change in the income distribution within the society. On the other hand, even improving education and /or the nutritional status of the population implies a reallocation of resources in favour of the majorities in LDCs, which implies some form of income redistribution.

Considering all the above arguments, it is rather difficult to prescribe any policy. The most feasible policy for fertility reduction likely involves increasing gradually the basic education of increasing sectors of the population. In addition, this must be accompanied with minor redistributions of income. It must be recalled that the increases in income, caused by improvements in education, may also affect income distribution positively (as in the basic model), and it is likely that fertility delines also improve income distribution.

In summary, a combination of educational improvements accompanied by some degree of income redistribution may be considered as the most feasible and coherent policy to brake the vicious circle of high fertility and poverty in LDCs.

7.3 Suggestions for Further Research

A general suggestion for further research is to increase the degree of realism of the models used.

One way of allowing a more realistic evaluation of an income redistribution policy is to directly and/or indirectly relate human capital formation with income distribution. On the one hand, education can be specified to be a negative function of fertility, a positive function of income distribution, or both (Anker, 1978). As well, the nutritional status of the population or level of calorie intake (DT) can be endogenized in the same way. In addition, life expectancy and the caloric level can be added as arguments in the production function. They should affect production positively in LDCs, via the effects of health conditions on productivity (Hall, 1983; Schultz, 1961). Such a way of expanding the analysis would provide a more realistic evaluation of an income redistribution policy. As well, such a model could explain the apparent paradox of societies that have achieved improvements in income distribution, declines in fertility, and a rapid rate of economic growth simultaneously (Rich, 1973; Kocher, 1973).

A different way of achieving realism would be to disaggregate the analysis to different sub-sets of LDCs (Gupta, 1983). The rationale for this disaggregation is related to the fact that each of the essential components of the income distribution multiplier on fertility are likely to be dependent on the level of development. That is to say, life expectancy has been postulated to affect fertility positively at low levels of development and negatively at higher levels of development (Easterlin, 1976; Gregory, 1976; Anker, 1978). As well, the effect of income distribution on life expectancy may be more important at lower than at higher levels of development. This occurs because the relationship between income and life expectancy may be more non-linear at lower levels of development. In other words, the causes of mortality associated with socio-economic conditions are less important in developed than in developing countries. Furthermore, fertility has been postulated to affect positively the female participation rate at low levels of development (McCabe and Rosenzweig, 1976). Finally, the effect of education on fertility has also been postulated to be dependent on the level of development (Schultz, 1981; Gregory, 1976).

All the above facts suggest that both the direct and the indirect effects of income distribution are likely to be positive and negative at lower and higher level of development, respectively.

A different expansion of the model would be to incorporate urbanization as an endogenous variable, explained in turn by income distribution, among other variables. Urbanization could be used either to explain the labour participation rates or fertility. This kind of expansion based on ideas adopted from the Todaro-Harris model of rural/urban migration (wherein income distributrion, as a proxy for the rural-urban wage rate differential, should affect urbanization negatively) might provide a better insight into the demographic side of the model.

REFERENCES

Adams, A. Nassau. 1971. "Dependency Rate and Savings Rate." *American Economic Review* 66: 472-475.

Adelman, Irma. 1966. "An Economic Analysis of Population Growth." *American Economic Review* 53: 314-39.

Adelman, Irma and Cynthia Morris. 1966. "A Quantitative Study of Social and Political Determinants of Fertility." *Economic Development and Cultural Change* 14: 129-57.

Adelman, Irma and Cyntia Morris. 1973. *Economic Growth and Social Equity in Developing Countries.* California: Stanford University Press.

Anker, Richard. 1978. "An Analysis of Fertility Differentials in Developing Countries." *The Review of Economics and Statistics* 60: 58-70

Arriaga, E. and Kingsley Davis. 1969. "The Pattern of Mortality Change in Latin America." Berkeley: University of California. Population Monograph Series, 6.

Atkinson, A. 1980. Wealth, Income and Inequality. Oxford University Press.

Bhattacharyya, A. K. 1975. "Income Inequality and Fertility: A Comparative View." Population Studies 29: 141-48.

Becker, Gary S. 1960. "An Economic Analysis of Fertility." In Demographic and Economic Change in Developed Countries. University-National Bureau. New York: National Bureau of Economic Research.

Becker, Gary S. 1965. "A Theory of Allocation of Time." Economic Journal 75: 493-517.

Becker, Gary S. and H. Gregg Lewis. 1973. "On the Interaction between the Quantity and Quality of Children." Journal of Political Economy 81:279-288.

Ben-Porath, Yoram. 1973. "Economic Analysis of Fertility in Israel: Point and Counter-point." Journal of Political Economy 81:202-33.

Bilsborrow, R. 1977. "Effects of Economic Dependency on Labour Force Participation Rates in Less Developed Countries." Oxford Economic Papers 29: 61-84.

Bilsborrow, R. 1979. "Age Distribution and Savings Rate in Less Developed Countries." Economic Development and Cultural Change 28: 23-45.

Bilsborrow, R. 1973. "Dependency Rates and Aggregate Saving Rates: Corrections and Further Analysis." University of North Carolina, mimeo.

Birdsall, Nancy. 1976. "Women and Population Studies: Review Essay." Journal of Women in Culture and Society 1,3: 699-712.

Birdsall, Nancy. 1977. "Analytical Approaches to the Relationship of Population Growth and Development." Population and Development Review 3: 63-102.

Birdsall, Fei, Kuznets, Ranis, and T. P. Schultz. 1979. "Demographic and Development in the 1980s." In World Population and Development - Challenges and Prospects. Edited by Philip Hansen. Syracuse: Stracuse University Press.

Birdsall, Nancy. 1980. "Population and Poverty in the Developing World." Working Paper 404 - World Bank.

Birdsall, Nancy. 1984. "Population Growth: Its Magnitude and Implications for Development." Finance and

Development 21: 10-15.

Boserup, Ester. 1965. The Conditions of Agricultural Growth. Chicago: Aldine.

Boserup, Ester. 1970. Woman's Role in Economic Development. London: Allen and Unwin.

Cain, Glen and C. Weininger. 1973. "Economic Determinants of Fertility." Demography 10, 2:205-23.

Caldwell, J.C. 1976. "Toward a Restatement of Demographic Transition Theory." Population and Development Review 4: 321-366.

Cassen, Robert. 1976. "Population and Development: A Survey." World Development 4, No 10-11.

Cassen, Robert. 1976. "Welfare and Population Notes on Rural India since 1960." Population and Development Review 1: 33-70.

Chang, Semon. 1984. Practioner's Guide to Econometrics. University Press of America.

Chenery, Hollis, Mutek Ahluwalia, Richard Jolly and John Duldy. 1974. Redistribution with Growth. Baltimore:

John Hopkins University Press for the International Bank for Reconstruction and Development.

Cline, R. William. 1972. Potential Effects of Income Redistribution on Economic Growth: Latin American Cases. New York: Praeger Publishers.

Dahlby, B. 1985. "Ranking Income Distribution in a Harsanyi Framework." Research Paper 85-12, University of Alberta.

De Tray, Dennis N. 1976. "Population Growth and Educational Policies: An Economic Perspective." In Population and Development. Edited by R. G. Ridker. John Hopkins University Press.

Dixon, Ruth. 1976. "The Roles of Rural Women: Female Seclusion, Economic Production and Reproduction Choice." in Population and Development. Edited by R.G. Ridker; pp. 290-316. John Hopkins Press.

Easterlin, Richard A., Robert A. Pollack, Michael L. Wachter. 1976. "Toward a More General Economic Model of Fertility Determination: Endogenous Preferences and Natural Fertility." Presented at the National Bureau of Economic Research Conference on Economic and Demographic Change in Less

Developed Countries, September 30 - October 2, Philadelphia.

Enke, Stephen. 1971. "The Economic Consequences of Rapid Population Growth." Economic Journal 81: 800-811.

Fields, S. Gary. 1980. Poverty, Inequality and Development. Cambridge University Press.

Flegg, A. T. 1979. "The Role of Inequality of Income in Determination of Birth Rates". Population Studies 39: 457-478.

Freedman, Deborah. 1976. "Mass Media and Modern Consumer Goods: Their Suitability for Policy Intervention to Decrease Fertility." In Population and Development, Edited by R.G. Ridker. John Hopkins University Press, pp. 356-386.

Friedlander, Stanley and Morris Silver. 1967. "A Quantitative Study of the Determinants of Fertility Behavior." Demography 4: 30-70.

Green, John H. 1976. Consumer Theory. London: MacMillan Publishers.

Gregory, Paul R., John M. Campbell and Benjamin S. Cheng. 1972. "A Cost-Inclusive Simultaneous Equation Model of Birth Rates." Econometrica 40: 681-87.

Gregory, Paul R., and John M. Campbell. 1976. "Fertility and Economic Development." In Population, Public Policy and Economic Development. Edited by Michael C. Keeley. New York: Praeger Publishers.

Gronau, Reuben. 1973. "The Effect of Children on the Housewife's Value of Time." Journal of Political Economy 81: 168-99.

Gronau, Reuben. 1977. "Leisure, Home Production, and Work. The Theory of the Allocation of Time Revisited." Journal of Political Economy 85, 6: 1099-1123.

Gupta, Kanhaya L. 1971. "Dependency Rate and Savings Rate: Comment." American Economic Review 61: 472-475.

Gupta, Kanhaya L. 1982. "Foreign Capital, Income Inequality, Demographic Pressures, Savings and Growth in Developing Countries: A Cross-country Analysis." Research Paper No. 82-9. University of Alberta.

Gupta, Kanhaya L., and M. Anisul Islam. 1983. "Population Growth and Aggregate Savings Behaviour in the

Developing Countries." Research Paper No. 82-9. University of Alberta.

Gupta, Kanhaya L. 1975. "Foreign Capital Inflows, Dependency Burden, and Savings Rates in Developing Countries: A Simultaneous Equation Model" Kyklos 28: 358-74.

Hall, Peter. 1983. Growth and Development: An Economic Analysis. Oxford: Martin Robertson and Company.

Hazledine, et.al. 1977. "Population and Economic Growth: a World Cross-Section Study." Review of Economics and Statistics 59: 253-263.

Heer, David M. 1966. "Economic Development and Fertility." Demography 3: 423-44.

Intriligator, Michael D. 1978. Econometric Models, Techniques and Applications. New Jersey: Prentice-Hall, Inc.

Jaffe, A. and K. Azumi. 1960. "The Birth Rate in Cottage Industries in Underdeveloped Countries." Development and Cultural Change 9: 52-63.

Jain, Shail. 1975. Size Distribution of Income: A Compilation of Data. International Bank for

Reconstruction and Development.

Janowitz, Barbara S. 1971. "An Empirical Study of the Effects of Socioeconomic Development on Fertility Rates." Demography 8: 319-30.

Johnston, J. 1975. Metodos de Econometria. Editorial Vicens.

Johnston, J. 1984. Econometric Methods. McGraw Hill, Inc.

Judge, G. et. al., 1980. The Theory and Practice of Econometrics. New York: Wiley.

Kasarda, John D. 1971. "Economic Structure and Fertility: A Comparative Analysis." Demography 8: 307-17.

Keeley, Michael C., 1975. "A Comment on an Interpretation on the Economic Theory of Fertility: Promising Path or Blind Alley." Journal of Economic Literature, 13: 461-68.

Keyfitz, N. 1968. Introduction to The Mathematics of Population. Menlo-Park, California: Addison-Wesley Publishing Company, 1968.

Kirk, Dudley. 1966. "Factors Affecting Moslem Natality." In Family Planning and Population Programs. Chicago:

The University of Chicago Press.

Kmenta, Jan. 1971. Elements of Econometrics. New York: Macmillan.

Krishnamurthy, K. 1966. "Economic Development and Population Growth in Low Income Countries: An Empirical Study for India." Economic Development and Cultural Change 15: 70-75.

Koutsoyiannis, A. 1977. Theory of Econometrics. London: MacMillan.

Kocher, E. James. 1973. Rural Development, Income Distribution and Fertility Decline. Occasional paper of the Population Council.

Kuznets, Simon. 1974. "Rural Urban Differentals in Fertility: An International Comparison." Proceedings of the American Philosophical Society 118 (1): 1-29 (February).

Kuznets, Simon. 1976. "Demographic Aspects of the Size Distribution of Income: An Exploratory Essay." Economic Development and Cultural Change 25:1, 1-94.

Kuznets, Simon. 1980. "Recent Population Trends in Less Developed Countries and Implications for the Internal Income Inequality." In Population and Economic Change in Developing Countries, edited by R.A. Easterlin. Chicago: University of Chicago Press.

Leff, Nathaniel H. 1969. "Dependency Rates and Savings Rates." American Economic Review 61: 886-96.

Leff, Nathaniel H. 1984. "Dependency Rates and Savings Rates: Another Look." American Economic Review 74: 231-33.

Leibenstein, Harvey. 1973. "The Economic Theory of Fertility Decline." Harvard Institute of Economic Research, April.

Lindert, H. Peter. 1980. "Child Costs and Economic Development" in Population and Economic Changes in Developing Countries. Edited by R. Easterlin. Chicago: University of Chicago Press.

Loehr, W. and Powelson, P. 1981. The Economics of Development and Distribution. Harcourt Brace editors.

Mauldin, W. Parker and Bernard Berelson. 1978. "Conditions of Fertility Decline in Developing Countries, 1965-75." Studies in Family Planning 9:5.

McCabe and Rosenzweig. 1976. "Female Employment creation and Family Size." In Population and Development, edited by R.G.Ridker. John Hopkins University Press.

Melvin, James and J. Markusen. 1984. The theory of International Trade and its Canadian Applications. The Buterworth Group of Companies.

Michael, Robert T. 1976. "On the New Theory of Consumer Behaviour." In The Economic Approach to Human Behaviour. Edited by G. Becker. The University of Chicago Press.

Michael, Robert T. 1973. "Education and the Derived Demand for Children." Journal of Political Economy 81: 128-164.

Mikesell, Raymond F. and Zinzer, James E. 1973. "The Nature of The Savings Function in Developing Countries: A Survey of the Theoretical and Empirical Literature." Journal of Economical Literature 11: 1-26.

Mueller, Eva. 1972. "Economic Motives for Family Limitation." Population Studies 26: 383-403.

Mueller, Eva. 1976. "The Economic Value of Children in Peasant Agriculture." Population and Development: The Search for Selective Interventions. Edited by Ronald G. Ridker. Baltimore: John Hopkins University Press, 1976.

Myrdal, Gunnar. 1972. "Population Prospects and Population Policy." In Population Analysis and Studies. Edited by Ishrat Z. Hussain.

Oeschli, Frank William and Dudley Kirk. 1975. "Modernization and the Demographic Transition in Latin America and the Caribbean." Economic Development and Cultural Change 23, No. 3, 391-420.

Oey, Astra Measok. 1981. "Interrelationship between Demographic Factors and Income Distribution: Problems of Measurement, Description and Interpretation." In International Population Conference of Manila. Selected Papers Published by the Union for the Scientific Study of Population.

Preston, Samuel. 1976. "Causes and Consequences of Mortality Declines in Less Developed Countries During the

20th Century." Conference on Population and Economic Change in Less Developed Countries, September 30 - October 2. Sponsored by Universities - National Bureau Committee for Economic Research, New York (Draft), p. 20.

Ram, Rati. 1982. "Dependency Rate and Aggregate Savings: A New International Cross-Section Study." American Economic Review 72: 537-44.

Repetto, Robert. 1979. Economic Equality and Fertility in Developing Countries. Baltimore: John Hopkins Un. Press for Resources for the Future.

Repetto, Robert. 1974. "The Interaction of Fertility and Size Distribution of Income." (Mimeograph).

Repetto, Robert. 1976. "Direct Economic Cost and the Value of the Children." In Population and Development. op.cit.

Rich, William. 1973. Smaller Families Through Social and Economic Progress. Washington, D. C.: Overseas Development Council Monograph, No. 7.

Rodgers, G., B. 1979. "Income and Inequality as Determinants of Mortality: An International Cross-Section

Analysis." Population Studies 33: 343-52.

Rosenzweig, R. 1981. "Redistribution, Population Policies and Household Behavior: Implications for Population Growth and Economic Development." In International Population Conference of Manila. Selected Papers published by the Union for the Scientific study of Population.

Rusell, L. B. and C. S. Burke. 1974. Determinants of Infant and Child Mortality: Report of a Feasibility Study, Pts. 1 and 2. Washington D.C, National Planning Association

Ryan, Brice. 1952. "Institutional Factors in Sinhalese Fertility." Milbank Memorial Fund Quarterly 30: 359-381.

Sanderson, W. C. 1976. "On Two Schools of the economic of Fertility." Population and Development Review 2, 3/4: 469-478.

Schultz, T. W. 1961. " Investment in Human Capital." American Economic Review 51: 1-17.

Schultz, T. Paul. 1976. " Interrelations Between Mortality and Fertility." In Population and Development.

Edited by R.G. Ridker. John Hopkins University Press.

Schultz, T. P. 1980. "An Economic Interpretation of the Decline in Fertility in a Rapidly Developing Country." In Population and Economic Change in Developing Countries. Edited by R. A Easterlin. Chicago: University of Chicago Press.

Schultz, T. Paul. 1981. Economics of Population. Perspective on Economic Series, Michael L. Wachter and Susan M. Wachter editors.

Simon, Julian L. 1969. "The Effect of Income on Fertility." Population Studies 30: 327-41.

Simon, Julian L. 1974. The Effect of Income on Fertility. Chapel Hill, North Carolina: Carolina Population Center.

Simon, Julian L. 1976. "Income, Wealth and their Distribution as Policy Tools in Fertility Control." In Population and Development. Edited by R.G. Ridker. John Hopkins University Press.

Simon, Julian L. 1982. The Ultimate Resource. Princeton, N.J.: Princeton University Press.

Stolnitz, G.J. 1965. "Recent Mortality Trends in Latin America, Asia and Africa." Population Studies 19 (2): 117-38.

Singh, Baljit. 1972. "Population Economics."In Population Analysis and Studies. Edited by Ishrat Z. Hussain.

Thirwall, A. P. 1978. Growth and Development. 2nd Edition, MacMillan Press.

Todaro, Michael. 1985. Economic Development in the Third World. Third Edition. Longman.

Weintraub, Robert. 1962. "The Birth Rate and Economic Development: An Empirical Study." Econometrica 40: 812-17.

Willis, R. 1973. "A New Approach to the Economic Theory of Fertility." Journal of Political Economy 81, 2:14-65.

Williams, Anne D. 1976. "Review and Evaluation of the Literature." In Population, Public Policy and Economic Development. Edited by Michael Keeley.

UN Department of International Economic and Social Affairs. 1979. 1981. World Population Trends and Policies

Monitoring Report - Volumes I and II. Population Studies No. 79.

United Nations. 1971, 1972 and 1973. *Demographic Yearbook.*

UN Educational, Scientific and Cultural Organization. 1971, 1972,1973. UNESCO *Statistical Yearbook.*

United Nations. 1971, 1972 and 1973. *Statistical Yearbook.*

World Bank. 1982 and 1984. *World Development Report.* Oxford University Press.

World Bank. 1976. *World Tables.*